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ART. I.—*On a New Method of recording differences of North Polar Distance or Declination by Electro-magnetism;* by Prof. O. M. MITCHEL, Director of the Cincinnati Observatory.

I HAVE heretofore declined publishing any detailed account of the new methods of astronomical observation in use at the Cincinnati Observatory, partly because the subject was constantly developing by new experiments, and partly because at the New Haven meeting of the American Association for the Advancement of Science, this subject, at my request, was referred to a committee for examination. The report of this committee having now been made, and the whole subject having assumed (by another year's examination and experiment) a more definite and positive form, it is now proper to present some general features of this new method, some results already reached, and the probable applications which remain to be made when suitable instruments shall have been provided for the purpose.

Observers are well aware of the difference between observations for Right Ascension and Declination. In the first, the principle of *repetition* has been extensively introduced with the best results, while as to the other, reliance is mainly placed on the accuracy of a single bisection of the star observed on one declination wire. More than two years since a plan had been executed by myself, and applied to practice in the Cincinnati Observatory, by which, on the same night, during one and the same transit, a star or other heavenly body could be observed on *ten* declination wires, with all the precision due to a single observation by the

old methods. More than a year has elapsed since I presented to the American Association some three thousand observations, taken in twelve nights, by the new apparatus, (a number exceeding the recorded observations of a whole year at one of the oldest European observatories,) each of these observations presenting an accuracy superior to those obtained by the old methods.

This astonishing rapidity and accuracy gave rise to a debate, and finally to the appointment of the committee above alluded to. A multitude of observations have been made during the past year, (and in accordance with the request of the chairman of this committee,) varied with a view to test in every way the powers of the new machinery. The results, as will be seen by examining the report of the committee, were entirely satisfactory.

It is proper now to state that, by the new invention, the transit instrument is converted, (at trifling expense,) into a declinometer, or instrument for measuring N. P. D., or declination. The observer is released from the necessity of reading a divided circle, and the position of his instrument at the moment his star is bisected by the declination wire, is, by a single touch, engraved on metal, and stereotyped, to be read and examined when convenience may permit. On the swiftest moving stars, *ten bisections* are readily accomplished and engraved in the space of a single minute of time, and at a maximum hour angle of only thirty seconds of time. These records are now made on a circumference whose diameter is nearly twelve feet, and finally read up by a micrometer of as great perfection as can be applied to the measurement of any minute distances. The instrument used thus far is a transit by Dollond, the property of the U. S. Coast Survey, and furnished by the Superintendent of that work. It is of old construction, about five feet focus, and although the definition of its object-glass is satisfactory, yet the optical power is low, and a bisection by it is far inferior to one made with a powerful object-glass. The new machinery attached to this transit, to convert it into a declinometer, was made in the Observatory by my assistant and myself, and is, of course, comparatively rough. The micrometer was made in this city, and although of workmanship highly creditable to the artist, yet as it is the first ever constructed on this plan, it has been found comparatively defective, and quite incapable of detecting with certainty the minute quantities which have been presented for its examination. Perhaps no micrometer has ever been submitted to such severe tests.

Thus far in the application of the new methods, my examinations have been confined to zones not exceeding twenty-five degrees in width. There is no difficulty however in extending these researches through the entire heavens and comprehending on the same night the entire sweep of the meridian from north to south.

In case a known catalogue is under review, the amount of work done during the night will depend solely on the rapidity with which the finders of the telescope can be set. If we allow for each star three minutes, (which with an assistant to set has been found sufficient,) we have without difficulty 200 observations on twenty different objects within the hour, and for a night's work of five hours, one thousand wires or observations recorded on one hundred stars or other objects. If however the work done is independent of any catalogue, and we are sweeping the heavens in zones, there is no difficulty in recording both R. A. and declination on single wires just as rapidly as the stars present themselves, even up to 300 stars per hour of time. This has actually been done. For the purpose therefore of cataloguing the heavens, the new methods offer advantages of the highest importance.

We now present some of the results tending to demonstrate the degree of precision already reached in the determination of differences of declination. As the whole subject was entirely new, no advantage could be gained from the experience of other observatories, and hence the difficulties which have been met were encountered under the most unfavorable circumstances. Having however implicit confidence in the great principles involved in the new machinery, I never doubted for a moment that the discrepancies which arose would finally be traced to mechanical defects, or to accidental and unanticipated causes.

My attention has been exclusively directed to this single point. *Within what limits of error could the new apparatus repeat its own work on different nights, on stars whose difference of declination varied from a second or two of arc up to* 25° *or* 30°.

To convert the records into degrees, minutes and seconds, presents no serious difficulty, and has therefore not as yet occupied my attention, further than to demonstrate with certainty its practicability.

In my very earliest observations with *ten* declination wires, more than two and a half years since, a simple inspection of the record in the shape of ten delicate wedged-shaped dots on metal, with a powerful microscope, demonstrated at once the perfection with which these records were made within the narrow space occupied by these ten dots. The wires were as nearly parallel and equidistant as we could place them. Yet the small inequalities of distance were always measured with a precision only limited by the power of bisection under the circumstances existing during the observation. When the weather was tranquil and the stars steady, the most admirably accordant results were reached: on the contrary, when the stars were dancing or ill-defined, discrepancies were recorded, doubtless due to errors of bisection. It is quite unnecessary to present the evidence of accurate move-

ment within the above narrow limits, inasmuch as the wider range of observation will include the more restricted.

When on a comparison of the work of two different nights, the discrepancies were reduced to the fraction of a second of arc, it became manifest that the micrometer was (as built) incapable of measuring with certainty such minute quantities. I had neither time nor means to build a new and more perfect instrument, and finding the micrometer reliable for half a dozen revolutions of the micrometer screw, a method of intercomparison of the work of two different nights occurred to me, which with my defective micrometer would test in the most absolute manner the powers of the new machinery. This was as follows, viz.

The stars of the catalogue were observed during one night on the *odd wires*, 1, 3, 5, 7, and 9, leaving the spaces blank on the engraved record, which corresponded to the even wires 2, 4, 6, 8 and 10. Every thing remaining untouched, on the following clear night the same stars were observed on these even wires, and thus a decade of dots was recorded, of which five were engraved on one night, and five others on the following one.

These records thus intermingled and interlocked, were now easily read by the micrometer, and falling as they did within the limits of reliable performance of the micrometer, the capacity of the instrument to repeat itself on different nights was tested in the most absolute manner, no matter if the stars observed comprehended a zone of even 25° or 30°. It is proper to remark that in all these observations I was assisted by Mrs. Mitchel, the stars being taken by us alternately: the reading up was done principally by herself, while the duty of recording fell to me. In this way the results reached would be independent of any personal idiosyncracy, while the readings being made by one person and recorded by another, no bias could possibly be given to the person reading.

In our first experiment of interlocking observations, forty-eight hours elapsed before it became possible to remove the metal plate from the pier, during which interval of time there were constant changes in the atmosphere, with storms of rain and wind. It was therefore with no small anxiety, that on closing the observations the microscope was turned upon the decade of dots, the work of two nights at intervals of forty-eight hours. The examination was in the highest degree satisfactory. The dots were placed with a precision and beauty perfectly astonishing, and no eye, thus far with the microscope itself, has been able to mark the difference between a decade of dots struck on two different nights, and one struck all on the same night. It did not require the micrometer screw to decide the question as to whether the instrument had repeated itself on the two different nights. This was obvious from a mere inspection of the dots by the microscope. In two instances on the extreme stars there was a slight

deviation from the uniformity of the placing of the dots. I suspected this to be owing to the action of the wires attached to the arm and conducting the current from the battery through the electro-magnet. Ample length was given to the wire, but there yet remained in it a sufficient stiffness to affect the place of the arm in its extreme positions, by a minute amount. This was fully demonstrated by experiment on the following night. A star was brought to bisection on a wire, and while thus located, the conducting wires were gently touched by the hand of the observer and the instrument was seen to yield to every touch. A source of error was thus detected of a minute character indeed, but of vast importance where tenths of seconds of arc were the quantities under examination. The admirable agreement now found to exist uniformly between the work of different nights encouraged me to go back and remeasure with greater care the old work still remaining engraved on the plate. By using a mean of two or three measures the observations were brought to the most surprising coincidence. I did not attempt a remeasure of all the observations, but contented myself with a rigid examination of a single pair of N. A. stars, among whose observed differences of declination average discrepancies existed. I copy the final results, remarking simply that the observations were made between the 26th May and the 30th June inclusive.

The following are the decimals of a revolution of the micrometer screw in the ten observations.

					Second of arc.
α Coronæ to ε Bootis	·6836	Diff. from mean	·0017	=	0″·068
" "	·6609	" "	·0210		0 ·840
" "	·6891	" "	·0072		0 ·286
" "	·6883	" "	·0064		0 ·256
" "	·6906	" "	·0085		0 ·340
" "	·6757	" "	·0052		0 ·208
" "	·6699	" "	·0120		0 ·480
" "	·6886	" "	·0067		0 ·268
" "	·6905	" "	·0086		0 ·344
" "	·6784	" "	·0054		0 ·220
	Mean ·6819				0 ·340
				Prob. error,	0″·250

α Cor. to ε Bootis, Greenwich Obs., 1840,	0″·05	
" " "	1 ·61	
" " "	1 ·64	
" " "	1 ·02	
" " "	1 ·25	
" " "	2 ·67	
" " "	1 ·39	
" " "	0 ·81	
" " "	2 ·05	
" " "	2 ·52	
	1 ·401	Prob. error, 1″·3.

I shall now present a few measures of the sun's diameter, in which it must be observed that only relative quantities are obtained. Taking the N. A. as accurate on any one day of those indicated in the observations, we found the power of the new apparatus to trace the apparent changes in the sun's diameter. This is not yet absolute work.

Observations of the ⊙ Diam. Cin. Obs. Sept., 1850.

	Obs.	Comp.	Diff.
Sept. 3,	1906·68	1906·40	+0·28
4,	1907·40	1906·80	+0·60
5,	1906·82	1907·40	−0·58
6,	1907·62	1907·80	−0·18
7,	1906·73	1908·40	−1·67
9,	1910·74	1909·40	+1·34
12,	1911·58	1910·80	+0·78
13,	1910·17	1911·40	−1·23
16,	1912·44	1913·00	−0·56
17,	1912·65	1913·40	−0·75
19,	1914·74	1914·60	+0·14
20,	1916·00	1915·20	+0·80
21,	1916·62	1915·60	+1·02
1851.			
May 15,	1900·10	1900 02	+0·08
22,	1897·80	1897·60	+0·20
24,	1897·46	1896·80	−0·66
26,	1896·07	1896·20	−0·13

The work in 1850 was measured with the defective micrometer, and I attribute the increased discrepancies to this cause, rather than to any inaccuracy in the observations or records.

On the application of the principle already explained, of intermingling the observations of two different nights, most of the large discrepancies which had for a long time annoyed me, and which I felt were due to imperfections in the micrometer (but which I had not hitherto been able to demonstrate) all disappeared, and the results have since exhibited the most surprising harmony. I shall present only a few specimens of the work done, as a more full and elaborate report will be made hereafter.

Observations of June 16th and 17th, 1851.

		16th.	17th.	Diff.	Seconds.
Observer, M.	ε Bootis to B. A. C. 4969 L.	6060	6064	0004	0″·016
"	L. α Coronæ	6508	6420	0088	0 ·352
"	M. 4706	3397	3288	0109	0 ·336
"	M. α Bootis	8877	8687	0190	0 ·760
"	M. 4933	8882	8663	0199	0 ·796
"	L. 5120	1430	1268	0162	0 ·648
"	L. α Serp.	2245	2252	0007	0 ·028
					0 ·418

			16th.	17th.	Diff.	Seconds.
M.	ε Bootis	to 4969 L.	·6060	·6064	0004	0″·016
	4969	" α Cor. L.	·0448	·0351	0097	0 ·338
	α Cor.	" 4706 M.	·6889	·6873	0016	0 ·064
	4706	" α Bootis M.	·5480	·5399	0081	0 ·324
	α Bootis	" 4933 L.	·0051	·9946	0095	0 ·380
	4933	" 5120 L.	·2553	·2605	0052	0 ·208
	5120	" α Serp. M.	·0815	·0992	0177	0 ·738
						0 ·302

I present one more specimen of the same kind of work, with some slight additional security for accuracy, simply remarking that here again the stars were observed by L. and M. without any specific order.

					Diff.	Seconds.
B. A. C.	No. 6084,	to 6323	5820	5896	0076	0″·304
"	"	ε Bootis	1335	1319	0016	0 ·064
"	"	α Coronæ	1407	1399	0008	0 ·032
"	"	6657	1662	1662	0000	0 ·000
"	"	6106	6430	6614	0234	0 ·936
"	"	6589	7340	7380	0040	0 ·160
"	"	α Bootis	1530	1670	0140	0 ·540
"	"	6110	1669	1699	0030	0 ·120
"	"	α Herculis	9980	0046	0066	0 ·264
"	"	α Serpentis	0540	0576	0036	0 ·140
						10)2 ·560
						2)0 ·256
						0 ·1280

Here it will be seen there is no accumulation of error due to the increased distance between the stars observed. This will also become more evident by examining the observations of intervals between wide stars on the preceding nights already reported.

I am now satisfied that the errors which yet remain, may be diminished one-half by the use of ten instead of five declination wires—and finally, that all work for difference of declination between stars may be accomplished with an accuracy equal to the best micrometer work, when the stars are but a few seconds apart.

The best work done in the world, (so far as I know,) has been accomplished in the Imperial Russian Observatory at Pulkova, and is reported by M. Struve in his great work on that institution. By the greatest refinement of art and skill on a few stars, the accordance between the determinations of different nights has been brought to within a limit of probable error of two-tenths of one second of arc. It will be seen by examining the results reported, that the new method, in the very infancy of its application, with defective instruments, low optical power, and with every possible disadvantage to contend with, has already rivalled

in accuracy the best work ever done. Indeed the last work reported greatly surpasses the Pulkova work in accuracy, as the average error on ten differences of declination amounts to no more than twenty-five hundredths of one second of arc, while the average error in the Pulkova observations amounts (on differences of declination) to forty hundredths of one second of arc.

But the old methods have already been pushed to their ultimate limit of attainable precision. Of this, I think any one will be convinced who will read M. Struve's admirable History of the Pulkova Observatory and its instruments. On the contrary, in the new method almost nothing has been done. Any one who has used telescopes of low power and those of great power, need not be reminded of the extraordinary advantage which high optical power and good definition gives in bisecting a star.

In the great refractor of the Cincinnati Observatory, ε Bootis is divided into two beautiful stars some two seconds of arc asunder, each round and sharp, while in the small instrument used in the foregoing observations the same star appears as a single object, a large mass of light. In case it were possible to employ the optical power of the great refractor, the most astonishing increase of accuracy might be anticipated. If such an object glass were mounted as a transit, the records would then be made very conveniently on the circumference of a circle thirty feet in diameter, and a second of arc would occupy a space nearly three fold greater than that now in use by me, and fourfold greater than is elsewhere employed (so far as I know) in the world. Again, thus far it must be remembered that the preceding results are the means of *five wire observations*. There is no difficulty in increasing the number of wires to ten or even to fifteen, should it be desirable. In short, the new method is capable of almost indefinite expansion and increased accuracy—1. By increase of optical power. 2. By perfecting the mechanical arrangements. 3. By increasing the radius of the recording circle. 4. By increasing the number of observations, or the number of declination wires.

The new method also involves a principle of wonderful value in the delicate work to which it must be applied—I mean the power of stereotyping the positions of the instrument, so that the observations may be scrutinized at leisure and be read and re-read until the error of reading up shall be reduced to an insensible quantity; this cannot be done in any other method.

What then may we not anticipate from the application of this new machinery under favorable circumstances to the examination of the heavens. If Struve dared pronounce his instrument competent to the determination of parallax, proper motion, &c., with results discrepant to two-tenths of one second, then indeed has the new machinery converted a small inferior transit into an instrument competent to cope with these grand mechanical questions.

Apply it then to instruments of perfect construction, of high optical power, with equal advantages of high mechanical perfection, with a full ten wire diaphragm, interlock the observations until the power of the micrometer is fully and positively determined, and then who will dare to anticipate the results which may be reached by such a combination of science and mechanical power. Motions which have hitherto required centuries for their detection and measurement, variations in the proper motions of the fixed stars, which have only been suspected, parallax annual and systematic, even the positions of the double stars themselves, may not all these, to say nothing of aberration, nutation, precession, fall fully within the range of rapid and positive research.

With the delicate and powerful machinery for determining R. A., on which no less than twenty-five wires are successfully employed, combined with this no less powerful means of measuring difference of declination, may we not hope that even in the lifetime of a single observer some of the dark problems of the heavens which now defy our utmost efforts, may be resolved and yield up their long and deeply concealed mysteries. My only regret is that I do not possess the means to execute an immediate application of these new methods to the resolution of these high and profound problems.

ART. II.—*On the Distribution of Manganese; on the Existence of Organic Matter in Stalactites forming Crystallized and Amorphous Crenate of Lime; and on the Origin of Stratification;* by DAVID A. WELLS, Cambridge, Mass.

1. *On the Distribution of Manganese.*

THE occurrence of pebbles and water-worn stones in many of the streams and water-courses of New England, which have their origin among, and run over, igneous and metamorphic rocks, is by no means uncommon, and has doubtless attracted the attention of every observer. When the bed of a stream in which they occur is examined, the colored pebbles and stones will be found at intervals, generally after or below a fall or rapid, and not immediately above. This coloring matter which is wholly superficial, and of different degrees of lustre, is due to an incrustation of the black oxyd of manganese, and occurs independently on almost every variety of stone.

In the Edinburgh new Philosophical Journal for July, 1851, Dr. John Davy calls attention to somewhat similar incrustations in England, of which he says as follows; "Though always superficial, in one spot the incrustation is so thick as to be available for use; and in this instance the black oxyd of manganese

acts as a cement, forming a bed of conglomerate several feet thick. Whence this incrustation is derived, or how produced, is not obvious. Restricting the view to the spots where it occurs, it might be supposed to be a deposit from running water. But when it is seen that the coloring matter is not to be detected on rocks *in situ*, the fixed rocks in the course of the stream, the idea ceases to be tenable, and the inference seems to be unavoidable, that the sand, pebbles and stones so colored have been incrusted with the oxyd before they had been carried down to the spot where they are found loose, or when in the form of conglomerate, that the cementing oxyd has been brought by water exuding from some rock or stratum containing manganese in a minor degree of oxydation, and acquiring the higher degree by the absorption of oxygen and at the same time the cementing quality." Dr. Davy also infers that manganese exists in the vicinity of these incrustations in large quantities, and advises special inquiry in search of it.

Before the publication of the article referred to, by Dr. Davy, the subject of these incrustations had attracted the attention of Dr. A. A. Hayes of Boston, and myself, and we believe the following to be a full and satisfactory account of the origin of this phenomenon.

The manganese exists in almost all the igneous and metamorphic rocks of New England, and I may say in other parts of the world, generally as a double carbonate of lime and manganese. When the waters of the springs, brooks and rivers flowing over these rocks, become charged with soluble organic matter, in the state of crenic, apocrenic, or humic acids, drained into them in consequence of rains or inundations, from swamps and peat-meadows, the carbonates of lime and manganese enter into solution. At such times manganese may generally be detected in these waters, as has been done by Drs. C. T. Jackson, A. A. Hayes, and others. When the water holding the manganese in solution becomes broken and thrown up in the passage of falls or rapids, consequently exposing it to the influence of the atmosphere, the manganese passes from a low state of oxydation, to the insoluble peroxyd, and is deposited for a considerable extent upon the rocks and pebbles below. It will thus be found upon examination, that at intervals in the bed of the stream, the stones are completely blackened or discolored, while in other places no such depositions exist. Beautiful examples of this phenomenon may be seen at some points on the Merrimac river, and indeed in almost every rivulet in New England.

I have also noticed similar depositions between the divisional strata planes of sandstones in the valley of the Connecticut, thus showing that apparently the same agencies were at work during the deposition of these rocks as at the present day.

As an example of the extent to which manganese exists in some of the older rocks of New England, I submit an analysis of an altered rock, occurring somewhat extensively in the neighborhood of Nahant. The analysis was made at my request by Mr. John Hague of the Cambridge Laboratory, and afterwards verified by Mr. Joseph Ela.

$Si\,O^3$,	52·17
$Fe^2\,O^3$,	9·78
$Mn^2\,O^3$,	26·72
$Al^2\,O^3$,	8·43
Ca O,	0·37
Mg O,	0·60
HO,	2·02
Total,	100·09

2. *On the existence of Organic Matter in Stalactites and Stalagmites, forming Crystallized and Amorphous Crenate of Lime.*

In the eighth chapter of Liebig's Agricultural Chemistry, edited by Playfair, there is given the result of some examinations of stalactites from caverns in Germany, and from the vaults of old castles upon the Rhine, made with the view of ascertaining the fact of the presence, or absence of organic matter in these bodies, either combined or uncombined.

The result may be stated in the words of the author, Prof. Liebig. The stalactites from the caverns "contain no trace of vegetable matter, and no humic acid, and may be heated to redness without becoming black." In the stalactites from the vaults and cellars of old castles, he says, "we could not detect the smallest traces" of humic acid. "There could scarcely be found a more clear and convincing proof of the absence of the humic acid of chemists in common vegetable mould." Under the term humic acid, Prof. Liebig undoubtedly means to include all those organic acids arising from the decomposition of vegetable matter, and which have received the names of crenic, apocrenic, geic and humic acids.

Having been informed by Dr. A. A. Hayes of Boston, that he had in numerous examinations arrived at results directly opposed to those of Prof. Liebig, I was induced at his suggestion to make an examination of a large number of stalactites and stalagmites obtained from various localities, with reference solely to the presence or absence of organic matter in these bodies.

The specimens examined were all from caverns, or rock formations, and were obtained from various parts of the United States; from Trieste in Austria, Malta, and the Sandwich Islands. In color they varied from an almost pure white, to red, yellow and brown of different shades; and in crystalline character, from a

structure resembling arragonite, to a variety entirely wanting in symmetrical arrangement, or a mere incrustation. The specimens were dissolved in dilute hydrochloric acid, the flocculent matter separated, collected and washed, boiled in caustic potassa, carbonate of ammonia or carbonate of soda, and then tested in the usual way for crenic and apocrenic acids by acetate of copper and carbonate of ammonia. In all the varieties, with one exception, abundant flocculent organic matter was separated, which on testing gave evidence of crenic acid in considerable quantities, with doubtful traces of apocrenic acid. The exception alluded to was the specimen examined from Trieste, which did not afford any appreciable flocculent matter on dissolving in acid. The greatest quantity of organic matter was found in stalactites of a deep yellow color, highly crystalline and uniform in character, and in the portions examined perfectly homogeneous and free from layers, or intervening bands indicating different periods and changes in deposition. As the presence of iron could not be found in the acid solution, it is inferred that the color of these yellow stalactites must be owing in great part to combined organic matter, existing as crenate of lime. In specimens like the spar ornaments from the Rock of Gibraltar, with which all are familiar, the coloring and delicate shading is also probably due to organic matter.

Dr. Hayes informs me that he has also found organic matter in arragonite in sufficient quantity to separate in flakes, while the specimen was dissolving in acid.

From these statements it must, I think, be inferred, contrary to the view of Liebig, that organic matter does exist in stalactites generally, as an acid combined with the lime, and imparting to them their various colors. I would by no means call in question the accuracy of the experiments of Prof. Liebig, further than that as far as my observations extend, crenic acid in the presence of lime, and combined with it passes over like oxalates, upon heating, into carbonates, without perceptible blackening.

It may here be added that Prof. Johnston of England, describes a compound of alumina with crenic acid, occurring in caves of granite upon the coast of Cornwall. This mineral has received the name of Pigotite, and is observed in places where the surface water trickles down over the granite rocks. From this it may not be inappropriate to apply the term *crenite* to those lime formations in which crenic acid occurs in considerable quantities.

Results similar to those announced above, have been obtained by Dr. C. T. Jackson, as well as by Dr. Hayes of Boston. Dr. J. Lawrence Smith informs me that he has frequently met with crenic acid in lime concretions from Asia Minor, and its existence in stalactites was also announced by Dr. Emmons of Albany, some years since. My results can therefore be considered but as the verification of those obtained by others.

3. *Observations on the Origin of Stratification.*

The general idea respecting the origin or cause of stratification, as expressed in geological text-books, or as inferred from the writings of geologists, seems to be this; that strata or the divisions of sedimentary matter have been produced either by an interruption of deposition, or a change in the quality of the material deposited. This idea is well illustrated by the deposition of matter of tides or inundations, its subsequent consolidation, and a renewed deposition on the plane of the former deposit. That such is really the cause of stratification in very many or most instances, I do not dispute; but that there are other causes which tend to produce and have produced stratification equally extensive and varied, is, I think, clearly shown by the following observations.

My attention was first drawn to the subject during the past summer, while engaged in the analysis of soils. By the process adopted, the soil was washed upon a filter for a considerable number of days, in some cases for a period as long as two weeks, and subsequently dried at a temperature of 250° Fah. The residue of the soil left upon the filter, consisting chiefly of silica and alumina, was found after drying, in every instance to be more or less stratified, and that too by divisional planes in some cases not at all coincident with any division of the materials, although this is apt to take place. The strata so produced were in some instances exceedingly perfect and beautiful, not altogether horizontal, but slightly curved, and in some degree conforming to the shape of the funnel. The production of laminæ were also noticed, especially by the cleavage of the strata produced into thin, delicate, parallel plates, when moistened with water.* These arrangements, it is evident, were not caused by any interruption or renewal of the matter deposited, or by any change in the quality of the particles deposited, but from two other causes entirely distinct, and which I conceive to be these; first, from a tendency in earthy matter, subjected to the filtering, soaking and washing of water for a considerable period, to arrange itself according to its degree of fineness, or perhaps according to the specific gravity of the particles, and thus form strata; and secondly, from a tendency in earthy matter, consolidated both by water and subsequent exsiccation, to divide independently of the fineness or quality of its component particles into strata or laminæ. The tendency of this earthy matter is generally to divide on drying along the lines formed by the arrangement of the particles according to their nature or quality. This is not, however, always the case, as was proved by the observations noted, and which is also conclusively shown by the examination of almost any stratified rocks. At the clay slate quarries near Charlestown, Mass.,

* The laminæ so produced were not always parallel to the strata divisions, although parallel to themselves.

the lines formed by differences in the quality of the component particles is beautifully marked on almost every slab, yet the divisions into layers are not coincident, and there is not a tendency to divide along the lines of arrangement.

At some points in the valley of the Connecticut where the sandstones remain unaltered in any great degree by heat or dislocation, the stratification produced by these several causes may be clearly seen and studied. On the western edge of this deposit, opposite Springfield, we have rocks composed of layers which would at once be referred to the production of tides or inundations by the most inexperienced observer. The strata here vary from the fraction of an inch to an inch in thickness; they are also covered with mud-cracks, and the various markings which are usually found upon a shore or beach. In other portions of the valley we have strata divisions, occasioned by the lines which separate materials differing either in quality or nature; as the shales from the sandstones, the conglomerates from the fine sandstones, or the highly bituminous shales from those less bituminous. And then upon the extreme eastern edge of this sandstone deposit we find strata, the leaves of which measure from one to two, and some instances three feet in thickness, some layers embracing in themselves matter ranging from a coarse conglomerate to the finest sand; and yet none of this collection of materials, within the limits of the particular layers in which they are included, exhibits the slightest tendency to break or divide in any one direction more than another.

The observations here stated, I am happy to find have been also noticed to some extent by others conversant with the subject of stratification. Sawdust subjected to the filtering action of water, has been observed by Prof. Agassiz to assume a regular stratified appearance. The same has also been noticed by Dr. Hayes of Boston, in the vats in which clay used for the manufacture of alum is washed. Dr. Emmons of Albany has referred me to an instance of a clay bed in which the strata of one portion are distorted and inclined, apparently from a force acting laterally or from below, but which force evidently could not have so acted from the perfectly regular and undisturbed condition of the surrounding clay strata; the inclinations must, therefore, according to Dr. Emmons, be referred to a peculiarity of deposition or a subsequent division at an angle on consolidation. I have also noticed regular stratification in the dried deposit of a puddle in the streets, where no apparent change in the character of the materials deposited could be noticed, and where there was certainly no interruption of deposition.

If the divisions of stratification or lamination which I have thus pointed out be admitted, it is not improbable that many cases of what are now considered disturbed and tilted strata, are in none other than their normal condition.

ART. III.—*Instructions for making wet Preparations of Animal Substances;* by HENRY GOADBY, M.D., F.L.S., formerly Dissector of Minute Anatomy to the Royal College of Surgeons of England.

IT frequently happens to the naturalist, and the microscopic observer, to meet with animals, or tissues, which, from a variety of circumstances, cannot be retained in any other form than that of a *permanent preparation.* They may be small, and so delicate, that they would be entirely lost if put into a bottle; and in such a case, it is desirable to mount them, without delay, as preparations for the microscope.

If the object be merely a filmy tissue, take a piece of glass of good quality, good surface, and flat; the substance is not material.* Clean it with liquor potassæ or dilute sulphuric acid, or use both these fluids, mixing them on the glass; they effervesce, decompose each other, and at that moment, clean the glass; rinse it in clean soft water and dry it with either a clean muslin handkerchief, or a piece of chamois leather; now test it with a drop of water placed on the center of one side of the glass, and if the water can diffuse itself *evenly over the whole surface, the glass is clean;* if not, it must be made so.†

This, which is frequently the most difficult part of the whole process, being accomplished, place the glass in the vessel in which the tissue to be mounted lies in preserving fluid, and float it on to the glass; withdraw the latter carefully from the vessel. With a fine (needle) point adjust the tissue to the center of the glass, and soak up the excess of fluid with a camel's hair pencil, leaving enough to cover the preparation. Now take a piece of *thin* glass, such as is used by microscopists, previously cut of less width than the slide or glass on which the tissue lies, and having cleaned it by the mode described, hold it at one end by a pair of finely pointed forceps, and apply the other extremity, holding it almost vertically, to such portion of the other glass as to leave the preparation in the center of both.

Gradually lower the top glass, and the fluid will run before it until the preparation be covered, and the top glass finally rest upon the lower one.

A quantity of fluid will yet remain outside the top glass which must be carefully taken up with the camel's hair pencil until the

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* The best glass for this purpose is the "patent British plate," manufactured by Messrs. Chance at Birmingham.

† It sometimes happens that neither acid, nor potash can clean a piece of glass sufficiently well to enable it to endure the test proposed; in such case a watery solution of gum arabic may be used, or, what is still better—the human saliva will clean it instantly.

surface of the lower glass, around the top one, be made quite dry, when the following cement must be applied to the clean, dry glasses, to shut in the fluid, and render the preparation permanent.

Take Egyptian asphaltum and dissolve it in camphene to the consistence of a thick paste; this process is greatly facilitated by the application of moderate heat. Keep it in a well secured vessel, and label it. Then take *japanner's gold size*, which may be obtained at the varnish makers, but generally it is too thin, because new. Inspissate it by the continued application of heat until it acquire the consistence of molasses, then with a muller, upon a marble slab, grind up with the gold-size as much lamp-black as you can, until you have formed a *very stiff paste*; this should also be well secured and labelled. The properties of these ingredients are as follows:

Asphaltum is hard and brittle.

Gold-size is highly tough, and elastic, and retains these properties for many years. By combining elements respectively *too hard*, and *too* soft, the one is made to counteract the objectionable properties of the other, and the lamp-black not only assists to give good consistence to the whole, but is desirable from its indestructibility.

Japanner's gold-size is composed of boiled linseed oil, dry red lead, litharge, copperas, gum animi, and turpentine.

To use the cement, take equal parts of each of the above materials, taking care that the gold-size composition should rather preponderate over the asphaltum, than the contrary; mix them intimately on a slab with a small palette knife; if too thick to work well, add a few drops of camphene, *but beware of making it too thin.* Apply the cement, thus made, to the outer margin of the top glass; do not use too much for the first coat, but rather by successive layers, applied at different periods, fill with cement the space between the lower and upper glasses of the preparation, until a good solid layer be formed, when the process is complete. It is, however, most important *to isolate the several layers of the "black" cement*, for the turpentine contained in a newly applied coating will act upon, and partially dissolve, the old and dry layer; in this case, the upper surface being exposed to the atmosphere will speedily *dry* and *contract*, and acting upon the softened cement below the surface, will drive it between the glasses, and spoil the preparation.

Either of the following compositions may be used for the purpose of separating the layers of the black cement.

Gum arabic, ...	3 drams.
Sugar, ...	1 do.
Corrosive sublimate, ...	1 grain.
Water, sufficient to make a thick mucilage.	

Marine glue, dissolved in an excess of white-wood naphtha, to form a thin solution of the glue. This, which is by far the best application for the purpose, dries nearly as rapidly as it can be used.

Having devoted upwards of thirty years of my life to the dissection of small animals by the aid of the microscope, and in the preparation of the elementary tissues of all animals, from man downwards, and being desirous of preserving and making permanent the results of my (frequently) very tedious labors, my wants, in this respect, were necessarily peculiar. The ordinary form of vessel, then, (and now,) in common use—a bottle, was altogether unsuited to my especial necessity; I could not place a *bottle* under the microscope for the examination of its contents, nor see the preparations without the microscope, the aberration, resulting from the figure of the bottle, precluding the possibility of defining with precision, the preparation contained within. Thus, the work I had been able to accomplish by suitable optical assistance could not be rendered apparent to my friends, by the use of a microscope; and whether it were an exposition of the nervous system, or other organic structure of an insect, or a minutely injected tissue of a frog, or a man, they were alike inaccessible to unassisted vision; moreover, to increase my difficulties they required to be kept as *wet* preparations. Having been in the constant habit of dissecting under water, in tin pans of various forms and sizes, and always covering these pans with a plate of glass to keep out dust, &c., when they contained unfinished dissections, or an animal simply prepared for dissection, I was struck with the beautiful appearance of an insect, or other entire animal, lying as naturally as possible, with all its full proportions displayed, retaining its characters in their utmost integrity, and so arranged as to be easy of access to the most superficial observer. To my vision, there could not be a more charming sight, than a finished dissection of the nervous system in situ of any insect, especially of the Blatta Americana—one of which I dissected at ten years of age—while lying in the pan in which the dissection has been performed; and sorely have I grieved at the sadly changed appearance of the same insect, at the instant I placed it in a bottle containing alcoholic fluid, ostensibly *to preserve* it, but actually to complete its disfigurement. Neither could I suspend a delicate preparation in a bottle, in such a manner as to insure its safety. With a quantity of air always contained in the bottle, *the fluid* is put in motion by the act of taking up the vessel to examine its contents, and the particles of fluid beating against a delicate tissue will inevitably in time break or displace the structure that had cost the patient labor of many tedious hours to dissect and display. Thus, by my own act, not unfrequently, and by the carelessness of others, I was continually losing my preparations; and this determined me to

attempt a form of vessel that should agree, as far as possible in all general particulars, with the pans, in which, I used then, and still continue, to dissect. Believing *glass* to be the very best material for my purpose, I consulted several operative glass-grinders on the subject; who all declared the work I required could not be done, and that if it could be accomplished, the cost would prove prohibitory. Not to be diverted from my purpose, nor discouraged by the statements of the glass-grinders, I determined to try and work out my plans with my own hands, although I had not received education in any branch of mechanics. Moreover, in connection with my project as a whole, I required a good cement for the glass vessels, and some other preserving fluid than alcohol. These subjects occupied me more or less for twenty years, during which time the failures were frequently quite disheartening, chiefly as regarded the *mechanical* part. On one occasion, I possessed about three dozen of glass vessels, each full of fluid, hermetically sealed, and containing a minute dissection, which had remained permanent for a period of two years. A gas microscope had just been invented, and was then on exhibition in Bond street, London. In an evil hour I submitted my preparations to this instrument; the intense heat of the gases melted my cement, and all my treasured dissections were destroyed before my face—this occurred about eighteen years ago. In the years 1839–40 and 41, I worked most perseveringly at my glass cells, and vessels, with a view, either to complete the plan, or to give it up: at the latter end of '41 I possessed a large collection of preparations all of them contained in vessels similar to those I now use and intend to describe. I submitted them to the inspection of the Society of Arts who, having invited the assistance of a large number of eminent men, awarded me their large gold medal "for his method of putting up anatomical preparations." The medal was awarded in November, '41, and presented on the distribution day in '42.* I have felt it necessary in my own justification, to give this history of a plan of mounting zoological or anatomical preparations, now in very extensive use, as I observe the method is recommended and explained in a recent publication without giving me the credit of originating and perfecting it.

There are many objects for the microscope, of great zoological or physiological interest, which possess more substance than will allow of their being treated in the way already described, although their characters can be preserved only as *wet* prepara-

* The preparations here alluded to were subsequently purchased from me for £500 sterling, or $2500, by a private subscription, headed by H. R. H. Prince Albert, and presented by the subscribers to the Hunterian Collection, in the Royal College of Surgeons, where they now remain.

They were also rewarded by the late Sir Robert Peel, at that time First Lord of the Treasury, who presented me with a check, on the Royal bounty fund, for £150 —$750.

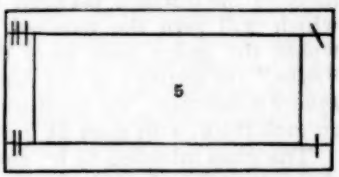
tions; for all such, a *cell*, or a glass box, must now be prepared, and the following is the way to proceed.

First, accurately measure the length, breadth, and substance of the preparation to be mounted; select a piece of flat glass of substance agreeing as nearly as possible with the thickness of the preparation and with a glazier's diamond cut off two pieces from one-eighth to three-sixteenths of an inch wide, and of equal length; these are to form the sides of the cell; the ends must be of the same width but not so long. Although the cell should *fit* the preparation in regard to *depth* or thickness, a good space should always be allowed around the sides and ends, for example: I desire to make a cell for a preparation measuring one inch long, and five-eighths wide, I should make the cell one and a half inch long, and one inch wide, *inside* measure, when finished the preparation looks better, is more accessible to the microscope because the sides of the vessel are not in the way, and, what is most important *there is more room for preserving fluid* than if the vessel be contracted to the actual size, or thereabouts of its contents. The *depth* should be exact for two reasons: one, that thereby the object is retained in the center of the cell, being lightly pressed upon by the top, and bottom glasses; the other, that there being no greater substance of fluid between the object and the microscope than must needs be, a better definition of the object is obtained.

When glass is cut with a diamond it always leaves a rugged, uneven surface; for example, when broken off, one piece of glass will present a series of projections, which have left corresponding cavities in the piece to which it was attached; when placed together, they lock into each other and the addition of a thin layer of cement will form a perfect joint.

I avail myself of this fact in constructing cells of the kind just described, thus: fig. 1 represents a piece of glass of the exact length and breadth, *outside measure*, that the cell is required to be.

1.



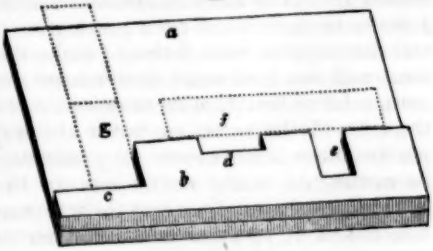
The two long pieces, or sides, are first cut, and before breaking them off they are marked with the scratch diamond so as to include the ends. As the width of the cell is not always sufficient to admit a number of lines, I first make a diagonal mark, then 1 and 2—rarely 3, which is unnecessary. I now separate the pieces, discard number 5, and take care to cement them to the bottom glass or slide, in the order in which they are marked, and to ensure accuracy in this respect, keep the marked surface upward. As it is necessary to have a bottom glass before we can cement the pieces just cut and marked, I proceed to give some

Description of the Slides.

My peculiar wants have necessitated slides of larger size than that proposed for general adoption by the Microscopical Society of London; moreover, I had a collection of uniform preparations on slides of my size, long before that Society had existence. The slide I chiefly use measures when cut $3\frac{3}{4}$ inches, by $1\frac{5}{8}$ths: the glass should be the "patent British plate," before referred to, which being ground and polished on both sides is generally very flat: its substance varies from less than $\frac{1}{16}$th to $\frac{1}{8}$th of an inch.

Cutting Board.—To cut the slides expeditiously and uniformly it is necessary to have a *cutting board*, fig. 2.* It consists of a mahogany board 11 inches by $9\frac{1}{2}$, half an inch thick and rectangular in shape; on one of its long sides, *a*, is fastened by means of pegs or screws and glue another piece of mahogany, the *guide board*, *b*, $2\frac{1}{4}$ inches wide and $\frac{1}{4}$ thick; this must be planed so as to be true, as the front is to form a *straight edge*. By reference to the figure it will be seen that spaces have been cut out of the guide board, the use of which will presently appear. A flat rule or gauge should be made of mahogany, 11 inches long and $\frac{1}{4}$ thick, the width to be ascertained as follows: mark out in card board a pattern of the slide intended to be used, apply the glazier's diamond to a line indicating one side of the pattern and accurately measure the distance between the diamond and the other side, which will give the required width of the gauge. In other words, the gauge must be of the width of the pattern, less *the "rake,"* (or setting) of the diamond. In addition to gauges, a *square* is essential; the most useful is of mahogany, one-fourth of an inch thick, with sides $6\frac{1}{2}$ inches long and solid, i. e., not open.

2.



CUTTING BOARD.

The glass intended to be cut into slides should be placed on the cutting board, and if none of its sides have a true edge, a narrow slip must be cut off its entire length to form one. The straight side of the glass must now be brought against the guide board to ascertain if either of the sides, at right angles to the cut side be perfectly square with it; if not, it is only necessary to square one side: for this purpose place the side to be squared so that it project a little beyond that part of the guide board which is cut away at *g*, apply the square, and cut off a narrow

* This figure should be reversed throughout to give correctly the form adopted.

slip in a direction contrary to the former cut: thus the two sides of the glass are made true.

Keep the glass still against the guide board and removing the square, apply the *gauge;* cut the whole length of the glass and you have the width of the slides. Now turn the squared end of the glass just cut into the space at *g*, pressing it firmly against the angles of the guide board, (which must also be made quite true,) place the gauge against the guide board in its former position, cut the glass transversely, as shown by the dotted line, and you have the length of the slide; and in this way cut up the remainder of the slip of glass as far as it will yield slides of the proper length.

In like manner the spaces *d* and *e*, in the guide board, give the length of other slides, the width of which has been cut previously with other gauges adapted to the purpose. By this arrangement of the cutting board one gauge is alone required to cut the width and length of a slide of any given dimensions. From the foregoing description it will be obvious that the gauges must be first made, the length of the spaces in the guide board determined by their assistance, and they must be cut in it before it be affixed to the cutting board.

Grinding the Glass.—Unless the slides are to be covered with paper, the sharp, rough edges left by the diamond cut should be removed by *grinding the glass.* This can be accomplished on a perfectly flat stone of sharp grit with water; the process is greatly facilitated by the addition of emery, but the best tool, in my experience, is a plate of *soft pewter.*

My plate was formed in a mould made for casting the pewter plates on which to engrave music; its outside measure, therefore, corresponds to the size of a printed page of music, but it is ½ an inch thick, and weighs 14 lbs. It is important that the surfaces be made quite flat, and every care should be taken to keep them so. *Soft* pewter is desirable because it contains a much greater quantity of lead than the hard, in which tin preponderates. The metal is used only as the vehicle of the cutting material, which is emery. The latter, in time, becomes thoroughly impacted in the metal, so that it will cut with the assistance of water alone, and the wear of the plate is too trifling to be estimated. When in use it should always be charged well with "superfine" emery, and water. Finer emery has no cut; and coarser tears the glass.

Hold the glass slide to be ground at an angle of about 45°, that *the outer line of the edge* may alone touch the plate of metal; grind by a quick, light, circular motion—to and from, rounds the corners—until the line be straight and beveled; change the position of the glass to grind the *opposite* outer line in the same manner; now hold the glass vertically, and make the edge smooth. By beveling the outsides of the edge of glass in the first instance they are saved from breaking, which is inev-

itable without this precaution; it is true that beveling can be done at any time, but it is not easy to grind out the deep irregular holes caused by splitting the edge. In this way, the four sides of the slide are to be ground.

To keep the pewter plate flat, grinding should invariably be conducted all over its surface; but as this is somewhat difficult with small pieces of glass on a large surface of metal, I devote one side of my plate for slides alone, and reserve the other for purposes where the utmost flatness is necessary. Its flatness, however, should be frequently tested with a straight edge, and if elevations appear, they should be reduced by grinding them down. Optical glass grinders and other mechanics, who require a plane grinding surface, have three similar tools; when one of them becomes untrue by use, it is ground with one of the others, until they present a like surface, neither of them being true. Tool No. 1 being now ground with tool No. 3, the inequalities left by No. 2 are obliterated, and a flat surface is the result. As it would be particularly inconvenient for me to carry with me three plates each weighing 14 lbs. for the sake of keeping one of them true, I resort to another, but equally efficient plan: I take a piece of plate glass of the same length as the pewter plate, the width not being very material, with plenty of emery and water I grind the metal all over its surface with the *flat* side of the glass until they present a corresponding surface; if the metal be not sufficiently flat, I turn the glass and grind the other side: by this process the flatness of the metal may be insured.

To abbreviate the time of edging the slides, it is expedient to hold one in each hand and grind them simultaneously; and although this may be somewhat difficult at first, a little practice will give all the facility and tact necessary for thus grinding *two* glasses in the time of one.

Cement for the Cells.—The slide being ready, the cell is to be cemented to it, and for this purpose a good, and water-proof cement is necessary. Canada balsam is too brittle; gum mastic is equally brittle and difficult to use, and I could not for some years find anything equal in toughness and durability to my own composition—gold size and lamp black—and I have now in my possession cells containing wet preparations cemented with it 14 years ago, every portion of which is perfectly sound. It is, however, in every respect, vastly inferior to the marine glue already alluded to. In the year 1842 my attention was directed to this composition by the newspaper accounts of experiments made with it at the Royal dockyards at Woolwich.

I consulted the patentee, Mr. Jeffery, and desired to know if it could be applied as a cement to glass; of this he knew nothing, but gave me some to try, and general directions how to use it. It failed; and for some months continued to fail, until the inventor made some specially for my use at the College of Sur-

geons, with which I had the most complete success. As made for general use the marine glue consists of different degrees of hardness, distinguished by numbers, from one, downwards; the particular composition made for me agreed nearly with the ordinary "No. 4," but as in addition to caoutchouc and shell-lac—the staple ingredients of the marine glue—this contained another and most important material, as applied to glass, it was agreed to call it "No. 4, G. K.;" subsequently the same valuable ingredient enters into the composition of every form of marine glue, so that "No. 4" is now a sufficient description of it.

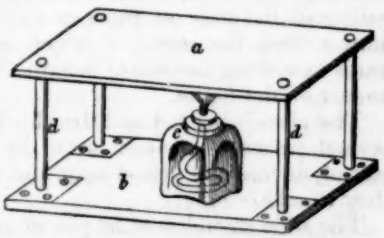
Another and very beautiful preparation of the marine glue has been made in this country, suggested by Dr. P. B. Goddard of Philadelphia.

It consists of caoutchouc dissolved in chloroform by the application of gentle heat to the consistence of a thick mucilaginous paste; then add clean, carefully selected tears of gum mastic, until the composition become sufficiently liquefied to use with a brush, when it should be filtered to free it from the dirt always combined with the gums in question. The gum mastic not only readily dissolves in chloroform, but it is a somewhat curious fact that it should reduce the thick solution of India rubber to the condition of a transparent, limpid fluid; it must not be made too thin however, for when dry it will be brittle from the excess of mastic. This is a very elegant cement; it can be used with or without heat, and when dry it possesses the great advantage of being perfectly colorless and transparent: I have not employed it for vessels of much size, but simply for shallow cells. The patent marine glue requires heat, and I have already described one mode of melting it; the following is the way *to cement the cells.*

Apparatus used in cementing the Cells.—I employ for this purpose an apparatus that I made many years ago for mounting preparations in Canada balsam. It forms an important part of the contents of my "manipulating box," and it is one of the things pirated by the author of the modern work already indicated.

A plate of wrought iron, $5\frac{3}{8}$ths by $2\frac{3}{8}$ths and $\frac{1}{8}$th thick, ground on its upper surface, (fig. 3, *a*,) is supported by four legs of brass wire (*d*) $\frac{3}{16}$ths diameter and 3 inches long in the clear; they screw into holes at the corners of the iron plate, and their free ends are placed in sockets in a mahogany board (*b*) the size of the iron plate, and $\frac{1}{4}$ thick. When in use, the plate becomes so hot that it cannot be touched

3.



with the hand, and the legs, by conducting the heat, mark the table; to render the entire apparatus more convenient, I found it better to add the mahogany board; the holes for the legs are defended with brass plates, and they fit *tightly* so that the whole can be moved bodily out of the operator's way. The spirit lamp (*c*) is 1¼ inch square and 2¼ high to the top of the brass wick holder —exclusive of the ground glass cap. Every part of the glass that is to be coated with the marine glue should firstly be lightly painted with the fluid solution of it before described. Thus prepared, the slide and the four pieces of the cell should be placed on the iron plate, and the heat of the lamp applied beneath.

The position of the lamp should be frequently changed, to impart an equal temperature to the iron plate, for if there be too great accumulation of heat at any one point, the glass will instantly break: should the plate become unnecessarily hot, lower the wick, or remove the lamp for a short time.

The solid glue may be cut into long thin slips with a knife or scissors, and applied to the painted surface of the slide and pieces of the cell, until the glass be hot enough to melt it, when it should be distributed evenly over the glass by means of a stouter piece of glue held in a pair of short, strong forceps. Then search, for, and remove, particles of grit and dirt which are contained more or less in the glue—they are best seen by removing the glass from the iron plate and placing it on a piece of clean, dry, white paper; they can be easily removed by the point of a knife, or a piece of the solid glue. Extraneous particles are frequently broken into fragments between the glasses by the pressure necessary to form a joint, but they should always be removed, as they act mechanically as a wedge, and preclude the possibility of a permanent joint.

At a certain temperature the glue will bubble and boil, at which point it should be removed from further contact with heat; otherwise it will be decomposed, and all its characteristics destroyed.

For neatness and uniformity, the cells should be placed in the center of the slides, and to accomplish this it is best to mark the outline of the slide on paper or card-board with a pen, and then draw a cross, the center of which is the center of the slide, its limbs extending the whole length of the long and the short diameter of the figure.

The glass being hot and the glued surfaces freed from dirt, the several pieces of the cell are to be turned quickly over with a pair of forceps and placed upon the slide in the relative position they should occupy.

The slide should now be placed on the card-board figure, each piece of the cell should be pressed down to the slide with two pieces of wood, and rubbed to and fro to express the excess of glue

and make as near approach to contact with the lower glass as is compatible with the thinest layer of glue. The four pieces of the cell having been cemented to the slide and to each other, its position can be readily adjusted to the center by the aid of the cross. Should the glass become a little too cool and the glue set, replace it on the iron plate and complete the adjustment.

Before the glass and the glue become quite cold and hard, it is desirable to remove the superfluous glue which holds most pertinaceously when cold: the best form of instrument for this purpose is the lozenge-shaped tool used by engravers, keeping the point close to the sides of the joint, or a knife point may be used, taking care not to scratch the glass. As a rule, it must be borne in mind that, whenever a cell consist of more than one piece of glass, it should be ground flat on the pewter plate before it is fit to be trusted: the slightest inequality, either in the substance of the glass at one end, or in the layer of the marine glue, will prevent the possibility of making a good joint hereafter with the top glass or cover.

To clean the glass perfectly I use a small piece of cotton wool gathered into a knot, held by a pair of strong steel forceps, and a drop or two of liquor potassæ, or a saturated solution of caustic potash, which softens the marine glue and admits of its removal. Care must be taken not to allow the potash to remain in contact with the joints, as it decomposes the glue, and will render the joints unsound. The glass should be well rinsed in a large quantity of clean water to remove the potash.

A top glass or cover must now be cut for the cell, and this should be somewhat smaller than the outer diameter of the cell on all sides to allow room for the cement. The edges of the cover, and the surface of the cell should be painted with the naphtha solution of marine glue; and the cell will then be ready for the reception of the preserving fluid, and the preparation. It is best to fill the cell over some other vessel to catch the excess of fluid that is sure to run over the sides; a small, shallow dish or saucer will answer this purpose; and if the cell be supported upon a level something placed in the dish, the better, as the operator will have his hands at liberty.

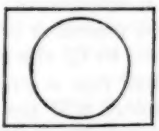
Having filled the cell with fluid, take a short but strong camel's (or badger's) hair pencil and rub the fluid into the corners, along the sides of the cell, and even the bottom glass, for this reason; in pouring the fluid into the cell, it remains *separated from the glass in every direction* by a filmy layer of atmospheric air, which can only be removed, and the fluid and glass brought in contact mechanically, or by the thin gum-water, or saliva, formerly referred to. If a vessel be sealed down without attending to this precaution, the air will be liberated by degrees and form a great number of minute bubbles, glistening in rows upon the

sides, in the angles of the cell, and even upon the bottom glass:—ultimately they coalesce and an air bubble of some size is the result. For the same reason, (the displacement of air,) the preparation must be placed carefully in the cell, and if it possess cavities in the under surface, they should be pressed out, if possible, while the preparation is entering the cell; and this should be managed so that one end of the preparation goes into the vessel first, and the remainder lowered gradually. A good steady stream of fluid should be poured into the cell, the preparation being held down by a camel's hair pencil or forceps, until all extraneous particles be washed away, and the fluid continue bright and clear. When at rest the fluid in the cell will present a *convex surface*, bounded on all sides by the painting of marine glue.

Now prepare one surface of the cover, either by the tongue or brushing on the fluid as before, and holding it by a pair of forceps at one end of its *longest* diameter, lower the other end to the cell, and let it down gradually—the excess of fluid running before—until it be in its place; then adjust it accurately, press down the cover till it touch evenly every part of the bed on which it is to rest, remove with a brush whatever fluid may yet remain on the outer edges, and paint them *once* more with the naphtha solution, including this time the top glass: apply the black cement, and the preparation is finished. Should another layer of black cement be required, allow the first to become quite dry, and isolate it, as before directed, with the naphtha solution: successive layers of the black cement must always be thus separated.

Drilling or cutting circular holes in glass for cells.—A more elegant mode of constructing a cell, is by drilling a circular hole through a piece of glass (fig. 4); but when I first attempted this plan, (in the years 1839–40,) the cost was prohibitory. At last I employed at the same time, three workmen in London to ascertain the lowest rate of cost at which holes of all sizes could be drilled in glass, in any quantity not less than one gross. Neither of these men employed the same means; one of them, a German, cut most beautiful cells, perfectly square inside, but he could not do them for less than 1*s.* 6*d.* or 36 cents each.

4.



Another made very indifferent cells at 1*s.* or 24 cents each; and the third made excellent work at 6*d.* or 12 cents each. Subsequent, another man undertook to do them equally well for half that sum, and ultimately I procured them at the same price, excellently cut, from Mr. Dennis of 1 Charles street, St. John's street road, London. The following is the plan of proceeding: procure a copper tube (or drill, as it is called) of the diameter you desire your cell to be: I have long since discontinued cells

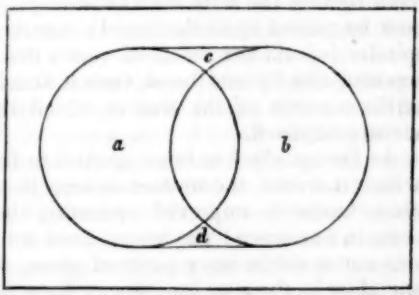
of *all* sizes, and chiefly use one of $1\frac{3}{16}$ths diameter, cut out of a square of glass $1\frac{1}{2}$ inch *full*, outside measure.

With my large slides such a cell enables me to preserve great uniformity in my preparations, affords abundant space for the transmission of light around the object, holds a sufficient quantity of preserving fluid, and the squares can be cut with the same gauge used for the slides themselves. The length of the drill may be from 1 inch to $1\frac{1}{2}$ long, and made to run true in a lathe. The squares of glass being all of the same size, I cement a number of them together with the marine glue, so as to form a pile of from one inch, to two inches high.

Where a *lathe* is used, it is important to face the pile of squares with something that has been already perforated with a hole the size of the drill, to enable the latter to enter at once upon its work, and prevent the stratching (and spoiling) the first cell. For this purpose, *brass* perfectly flat, can be used; but a better thing is a square of *plate glass*, one-fourth of an inch thick, already perforated by the same drill, and this should be kept for the purpose alone.

The copper drill is to be charged with fine, sharp cutting sand and water, and the block or pile of glass squares applied to it, and gradually pressed up by the tail spindle of the lathe, while the drill should revolve at a *moderate*, but not a *rapid* rate. When a number of cells are drilled, they can be easily separated from the block by placing the outer cell downwards on the iron plate and applying the spirit lamp: they can be removed one after the other with great rapidity, until only *undrilled* glasses remain, and to these other squares may be added if necessary. To make an oval cell, two round holes (fig. 5, *a*, *b*,) must be drilled so as to intersect each other; their proximity to be determined by the *length* of the oval required. The pieces that remain on each side, *c*, *d*, can be cut off with the diamond if the glass do not exceed one-eighth of an inch thick, otherwise a disc of copper, the diameter of a ten cent piece must be applied to the lathe, charged with sand and water on the edge, and it will speedily make the sides of the cell level.

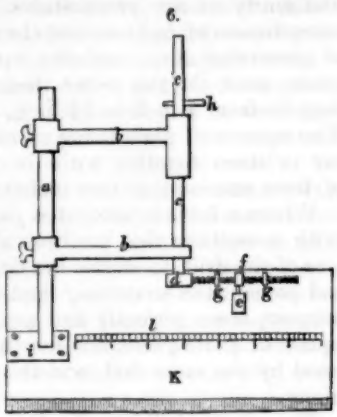
5.



There is another excellent method of cutting either round or oval cells of any size, *provided the glass do not exceed one-eighth inch in thickness*, for which I am indebted to Sir Charles

Babbage, the inventor of the celebrated calculating machine. Mount a glazier's diamond to cut a circle; this can be done in a variety of ways—I have mounted my diamond as shown in fig. 6. *a* represents a square bar of iron, 8 inches long, with a male screw at the lower end to fit a plate of iron (*i*) tapped to receive it, *b*, *b*, two arms 4½ inches long, clamped to the upright bar by thumb screws, the other extremity drilled and ground to receive *c*, which is a spindle, to the lower end of which is rivetted a screwed rod *d*, 4 inches long from the center. *e* is a box to receive the glazier's diamond when removed from the handle, and kept in its place by a tightening screw; continuous with this box is a square nut, *f*, perforated with a hole large enough to allow it to swing freely on the screwed arm. *g*, *g*, are square screwed nuts, one on each side of the diamond box.

6.



In adjusting the diamond to cut a disc, say three inches diameter, move it along the screwed arm until the point be coincident with 1½ inch as marked upon the scale (*l*) which has before been drawn upon the chamois leather which covers the board K; then bring the nuts close to either side of the diamond box, adjust it to its cutting angle, and then by means of a wrench in each hand *tighten* the nuts simultaneously. The glass to be cut may now be placed upon the board; remove the pin *h*, and lower the spindle (*c*) till the diamond touch the glass: then holding the screwed arm by one hand, turn it steadily round and it will describe a circle of the size to which the diamond has been previously adjusted.

As the spindle has been ground to fit the two collars through which it works, the motion is smooth and steady. Such a machine would be improved by casting the upright bar and the two arms in one piece: the height need not exceed six inches. Having cut a circle on a piece of glass, if the *disc* be wanted, cut the glass in three or four places *from the circular cut to the outer edge*, and carefully break off the pieces; but if a *cell* be wanted the *disc must be removed* without injury to the remainder of the glass, which is to form the walls of the required cell.

The cut, already made, gives the exact dimensions of the aperture required; now alter the position of the diamond on the screwed arm and cut a circle *within* the first, adjust again and

cut another circle within the last and so proceed cutting circle within circle as long as the diamond can be adjusted to cut, and the glass will then present a series of concentric circles.

Take a center punch and screw it point upwards in a bench vice; place the center of the *innermost circle* on the point of the punch, and get an assistant to hold the glass while the operator takes another center punch and placing its point *upon* the glass immediately over the point of the lower one, strikes the upper punch lightly with a hammer, *not to break* but to *pound* the glass lying between the two punches. Presently a small hole will be made; now bring the broken edge of the glass upon the lower punch, continuing the pounding motion until the hole be sufficiently enlarged to admit of using the "*plane*" of the small and light hammer with which the punch has been struck. At this stage of the process, the use of the upper punch should be discontinued, and the operator holding the glass himself, keeping an edge of the hole always supported on the lower punch while he lightly taps it with the plane of the hammer, not attempting to remove the *circles* as cut, but rather tracing the hole from the *center to the circumference*, (like making a cross in the glass,) and if it have been *cut*, not *scratched*, large pieces will fall out as soon as they have room enough, and the entire operation be finished in less time than it takes to describe it.

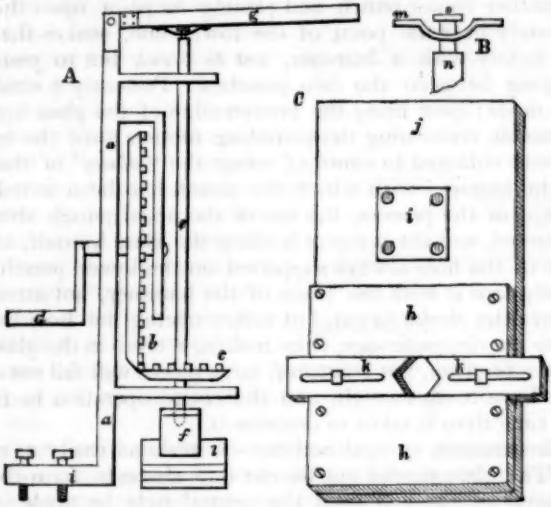
In like manner, an oval cell can be made as easily as a round one. The glass should not be cut into shape to form the *outer* dimensions of the cell until the central hole be made, as it is likely to break. Upon this plan a hole of any size can be easily cut in a plate of glass of any dimensions. Sir Charles Babbage told me that he once communicated this plan to a glazier, who employed it most extensively in punching holes in squares of glass to form the bottom plates of street gas lamps, for the transmission of the gas pipe.

I have already remarked that the above plan of cell-making is limited to glass one-eighth of an inch thick; my wants frequently required cells full as deep again; I could cement two or more shallow ones together and thus build up any required depth, but they look heavy and I prefer therefore to cut them out of plate glass of the proper thickness. When in London I could obtain the services of Mr. Dennis to cut anything that I required, at any time; but in this country, at this moment, I am altogether thrown upon my own resources. To meet my wants I have contrived a small, portable, and most efficient apparatus, by means of which any lad can cut cells as well as I can, and with this machine my son has cut for me the best cells I have ever had.

It consists of *a*, *a*, (fig. 7, A,) an iron support with three arms and a square plate at the lower end of it, cast in one piece. *b*, a vertical beveled wheel working *c*, a horizontal beveled wheel

by means of the crank *d*, the latter wheel, having for its axis a spindle, *e*, the lower end of which screws into the brass mount of the copper drill, *f*, whilst its other end passes through a collar in the upper arm of the iron support and is regulated in its action by the wooden lever *g*.

7.



Attached to the under surface of the wooden lever is a strong steel spring, about one inch wide, the profile of which is shown at B, fig. 7. *m* is the spring, to be screwed to the lever by the flat extremities. In the center of the curved portion there is a slit through which the upper part of the spindle, *n*, previously reduced for that purpose passes, and in which it can freely play; it is kept in its place by the button *o*.

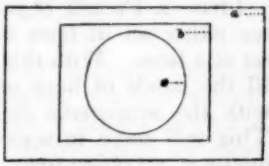
The square plate *i*, (A and C,) is screwed down to the board *j*, by four nut-headed screws. *h*, *h*, are two thick pieces of wood screwed on to the bottom board *j*, their inner edges being under cut to form a beveled groove in which the two pieces of wood marked *k*, being beveled to the same angle, may freely move.

In the center of the pieces marked *k* is a slit, through which passes a nut-headed screw to connect them with the lower board and to admit of their adjustment, their inner extremities are cut to form half a square and are intended to receive the block of glass placed diagonally, to be drilled by the machine. The block of glass, *l*, should be placed exactly in the center, and it can easily be secured in its position by clamping the side pieces of wood by means of the nut-headed screws and collars.

With this machine I employ superfine emery and water. It cuts best by a *dragging* motion; pulling the crank half round with one hand whilst the lever is kept down by the other; and then lifting up the lever and allowing *the crank to go the other half round without grinding*. By alternately lifting up the lever and pressing it down, the emery works into the cut; whereas, if the lever be kept steadily down either by a weight or by the hand, and the crank turned constantly round, the drill will be cut away much faster than the glass. This is not an expensive apparatus.*

The same directions apply to cementing the round and oval cells to the slides as those already given; and when finished they appear like fig. 8, where *a* represents the slide, *b* the cell cemented to it, and *c* the *well* formed for the reception of the preparation and the fluid.

8.



ART. IV.—*Notice of a new Object Glass made by Charles A. Spencer of Canastota, N. Y.;* by ALEXANDER S. JOHNSON, Esq.

Dear Sir:—In the latter part of July last I had the pleasure of visiting Mr. Spencer at Canastota, and of seeing a $\frac{1}{15}$th inch objective which he had then lately completed upon his new formula. Its qualities and performances so far exceeded those of any objective that I have ever seen or heard of, that I cannot doubt your microscopic readers will be pleased to be informed of them. Its angle of aperture was measured by us, with a brass circle graduated to half degrees. The body of the microscope was adjusted upon the circle so as to bring the objective to its focal distance from the centre of motion and the objective was illuminated by the direct rays of the sun, care of course being taken that no reflected rays should fall upon it. We measured from the point on one side where the extreme edge of the field was dark, the rest being full of light, to the corresponding point on the other side. The angle thus given upon repeated trials was 174½°.

The objective was then adjusted upon a Navicula Spencerii, one of the smallest individuals of that species, illuminated by

* Holes can only be drilled in the *very thin* glass, (that used for covers,) only by cementing a number of them together and *facing* them with a thicker glass; I could not procure any, some years ago, until I suggested this plan, which obviated all difficulty.

[A very convenient method of obtaining circular cells is to take a thick glass tube of requisite bore and have slices sawed off, of the thickness desired. This method has been recommended to us by Dr. J. Leidy of Philadelphia.—EDS.]

reflection of a white cloud from the concave mirror placed not obliquely but with its centre in the axis of the microscope. In this way the shell was well resolved into dots.

At my suggestion a $\frac{1}{4}$th objective of French manufacture was then used for illumination as an achromatic condenser, with the light from a white cloud reflected by the plane mirror, the whole accurately adjusted to the axis of the microscope and the image of the cloud brought in focus in the plane of the object. The dots upon the shell were thus shown with a sharpness of definition that I have never seen equalled by any other objective with any mode of illumination.

I have a French objective with which by oblique light I can see either set of lines on the Navicula Spencerii, but only one set at a time. With this objective and oblique light I can resolve all the bands of lines on Nobert's test of fifteen bands, while with the achromatic condenser I can only resolve nine bands. This will serve in some measure to illustrate the comparative merits of an object-glass capable of showing the dots on the N. Spencerii by oblique light and of one capable of showing them by an achromatic condenser.

We afterwards looked at a Grammatophora subtilissima from Greenport, with the achromatic condenser and the same adjustment, and I saw the cross lines steadily and with perfect distinctness, getting at the same time by glimpses the longitudinal lines.

The light failing us, as evening was approaching, we did not try in this way either the Amici test or the Providence Grammatophora, but in the evening we saw both these objects satisfactorily resolved into dots, by unreflected oblique light from one wick of a common bed-chamber lamp, burning oil, a homely but very effective method of illumination for objectives of large aperture.

Had I not lately met with "a complete manual on the use of the microscope, by Dr. Wythes of Philadelphia," in which in the enumeration of the makers of object-glasses, no mention is made of Spencer, while all persons desirous to see the markings on test objects are directed to mount them dry, I should not think it necessary to add that all the objects above mentioned were mounted in balsam.

The working distance of this objective, notwithstanding its immense angle of aperture is so great that it may be used upon objects covered with thin glass of medium thickness. Comparing the performances of this objective with the recorded performances of other object glasses which from time to time have appeared in the Journal, I cannot resist the conviction that it is the best objective ever produced, and far the best.

New York, Oct. 9, 1851.

ART. V.—*Notice of some undescribed Infusorial Shells;* by ALEXANDER S. JOHNSON, Esq.

IN a recent examination of the Piscataway and Richmond earths, guano from the Chincha islands off the coast of Peru and the so-called "Bermuda" earth, I have found a few infusorial shells heretofore unknown to me, and undescribed by Ehrenberg in his published lists of those localities. I have therefore ventured to describe them. Three of the species belong to a new genus, here described, the fourth is an Asterolampra, and the fifth appears to be a Eupodiscus.

ASTERODISCUS, n. g.—Free animalcules of the family Bacillaria, section Naviculacea. Lorica simple, bivalve, siliceous, circular, from the side biconvex, not forming chains. Umbilicus smooth, nearly circular, divided from its margin to the centre by imperfect septa, of which two unite midway to the centre, the rest radiating; between these septa the umbilicus is produced to the margin of the shell in radii, which are smooth and flat, the one proceeding from between the two united septa being in all species and individuals smaller than the others, as if from imperfect development. The space between these radii elegantly marked with minute dots arranged in eccentric curves.

The proximate genera Asterolampra and Asteromphalus are readily distinguished from this genus. In the former, all the divisions are symmetrical; in the latter, two umbilical septa are nearly parallel and the corresponding marginal radius is wanting.

The following are the three species observed:—

A. quinarius, with five marginal radii and umbilical divisions. Fossil in the so-called Bermuda earth.

A. senarius, with six radii and divisions. Fossil with the foregoing.

A. nonarius, with nine radii and divisions. Fossil at Piscataway, Md., and with the foregoing.

The other new species detected are as follows:—

Asterolampra septenaria, differs from A. marylandica, only in having seven radii instead of eight. Fossil in earth from Richmond, Va., and Piscataway, Md.

Eupodiscus? Tripes. Disc cellular like Coscinodiscus radiatus, with three tubular processes like those of the Eupodisci. Fossil in Chincha guano, near the coast of Peru.

Art. VI.—*On Coral Reefs and Islands;* by James D. Dana. Part Fifth.

From the Report on Geology of the Exploring Expedition under Capt. Wilkes, U.S.N.

2. *Causes modifying the Forms and Growth of Reefs.*

Coral reefs although (1) *dependent on the configuration of the submarine lands for many of their features,* undergo various modifications of form or condition through the influence of extraneous causes, such as (2) *unequal exposure to the waves;* (3) *oceanic or local currents;* (4) *presence of fresh or impure waters.* In briefly treating of these topics, we may consider first, reefs around high islands, and afterwards, atoll reefs. The effect of the waves on different sides of reefs has already been considered, and we pass on, therefore, at once to the influence of oceanic or local currents, and fresh or impure waters.

a. Barrier and Fringing Reefs.—The *existence of harbors* about coral-bound lands, and of entrances through reefs, is largely attributable to the action of tidal or local marine currents. The presence of freshwater streams has some effect towards the same end, but much less than has been supposed.*

There are usually strong tidal currents through the reef channels and openings. These currents are modified in character by the outline of the coast, and are strongest wherever there are coves or bays to receive the advancing tides. The harbor of Apia, on the north side of Upolu, affords a striking illustration of this general principle. The coast at this place has an indentation 2000 yards wide and nearly 1000 deep, as in the accompanying sketch, reduced from the chart by the Expedition. The reef extends from either side or cape a mile out to sea, leaving between, an entrance for ships. The harbor averages ten feet in depth, and at the entrance is fifteen feet. In this harbor there is a remarkable out-current along the bottom, which during gales, is so strong at certain states of the tide, that a ship at anchor, although a wind may be blowing directly in the harbor, will often ride with a slack cable; and in more moderate weather the vessel may tail out *against* the wind. Thus when no current but one inward is perceived at the surface, there is an under current acting against the keel and bottom of the vessel, which is of sufficient strength to counteract the influence of the winds on the rigging and hull. The cause of such a cur-

HARBOR OF APIA, UPOLU.

* The view here supported, is nearly identical with that presented by Mr. Darwin, (op. cit., page 68.) The arguments given were, however, written out in 1840, before his descriptions of coral islands were known to me. This fact may give additional weight to the opinions, inasmuch as they are therefore the conclusions of independent observers, and are substantiated by a distinct set of observations.

rent is obvious. The sea is constantly pouring water over the reefs into the harbor, and the tides are periodically adding to the accumulation; the indented shores form a narrowing space where these waters tend to pile up: escape consequently takes place along the bottom by the harbor-entrance, this being the only means of exit. This is a correct history of numerous cases about all the islands. In a group like the Feejees, where many of the islands are large, and the reefs very extensive, the currents are still more remarkable, and they change in direction with the tides. The general mode of action, however, is the same.

A current of water of the kind here represented, will carry out much coral debris, and strew it along its course. The transported material will vary in amount from time to time, according to the force and direction of the current. It is therefore evident that the ground over which it runs is wholly unfit for the growth of coral, since zoophytes are readily destroyed by depositions of earth or sand, and require a firm basement to commence growth. The existence of an opening through a reef requires, therefore, no other explanation; and it is obvious that harbors may generally be expected to exist wherever the character of the coast is such as to produce currents and give a fixed direction to them.

The currents about the reef grounds west of the large Feejee Islands, aid in distributing the debris both of the land and the reefs. In some parts, the currents eddy and deposit their detritus; in others they sweep the bottom clean. Thus, under these varying conditions, there may be growing corals over the bottom in some places and not in others; and the reefs may be distributed in patches, when, without such an influence, we should expect a general continuity of coral reef over the whole reef-grounds.

The results from marine currents are often increased by waters from the island streams; for the coves, where harbors are most likely to be found, are also the embouchures of valleys and the streamlets they contain. The fresh waters poured in, add to the amount of water and increase the rapidity of the out-current. At Apia, Upolu, there is a stream thirty yards wide; and many other similar instances might be mentioned. These waters from the land bring down also much detritus, especially during freshets, and the depositions aid those from marine currents in keeping the bottom clear of growing coral. These are the principal means by which freshwater streams contribute towards determining the existence of harbors; for little is due to their freshening the salt waters of the sea.

The small influence of the last-mentioned cause—the one most commonly appealed to—will be obvious, when we consider the size of the streams of the Pacific islands, and the fact that fresh water is lighter than salt, and therefore, instead of sinking, flows on over its surface. The deepest rivers are seldom over six feet, even at their mouths; and three or four feet is a

more usual depth. They will have little effect, therefore, on the sea water beneath this depth, for they cannot sink below it; and corals may consequently grow even in front of a river's mouth. Moreover, the river water becomes mingled with the salt, and, in most cases, a short distance out, would not be unfit for some species of coral zoophytes.

Yet when the rivers are large, like those of continents, the influence of the freshening waters is very decided, and prevails often over a wide extent of coast.

Freshwater streams, acting in all the different modes pointed out, are of little importance in harbor-making about the islands of the Pacific. The harbors, with scarcely an exception, would have existed without them. They tend, however, by the detritus they deposit, to keep the bottom more free from growing patches of coral, and consequently produce better anchorage ground: moreover, within the harbors they usually keep channels open through or over the shore reef sufficiently deep and wide for a boat to reach the land, and sometimes preserve a clean sand-beach throughout. That this is their principal effect will appear from a few facts.

The figure on page 366, vol. xi, of this Journal, has been described as a map of the reef of North Tahiti, between Papieti on the left, and Venus Point on the right.

a. The harbor of Papieti is enclosed by a reef about three-fourths of a mile from the shore. The entrance through the reef is narrow, with a depth of eleven fathoms at center, six to seven fathoms either side, and three to five close to the reef. This fine harbor receives an unimportant streamlet, while a much larger stream empties just to the east of the east cape, *opposite which the reef is close at hand and unbroken.*

b. Toanoa is the harbor next east of Papieti. The entrance is thirty-five fathoms deep at middle, and three and a half to five fathoms near the points of reef. There is no freshwater stream, excepting a trifling rivulet.

c. Papaoa is an open expanse of water, harbor-like in character, but is without any entrance; the reef is unbroken. Yet there are two streams emptying into it, one of which is of considerable size.

d. Off Matavai, the place next east, the reef is interrupted for about two miles. The harbor is formed by an extension of the reef off Point Venus, the east cape. There is no stream on the coast, opposite this interruption in the reef, except towards Point Venus, and at the present time the waters find their principal exit, east of the Point, behind a large coral reef, but a quarter of a mile distant.

From such facts, it would almost seem as if coral reefs grew best near freshwater streams. We cannot be surprised at the little influence they appear to have exerted when knowing that

none of these so-called rivers are over three feet in depth; and the most that they can do is to produce a thin layer of brackish water over the sea within the channels.

e. The annexed figure of the harbor of Falifa, Upolu, represents another coral harbor, as surveyed by Lieutenant Emmons. At its head there is a fine stream twenty-five or thirty yards wide, and three feet deep. Notwithstanding the unusual size of the river, the coral reef lies near its mouth, and projects some distance in front of it. Its surface is dead, but corals are growing upon its outer slope.

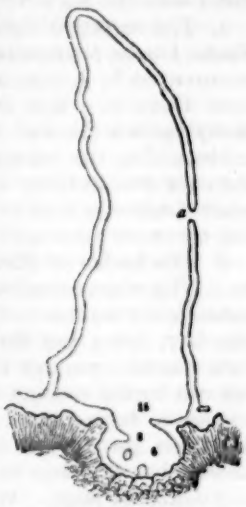
HARBOR OF FALIFA.

f. The harbor of Rewa, in the Feejees, may be again alluded to. The waters received by the bay amount to at least 500,000 cubic feet a minute. Yet there is an extensive reef enclosing the bay, lying but three miles from the shores, and with only two narrow openings for ships. The case is so remarkable that we can hardly account for the facts without supposing the river's mouth to have neared the reef by depositions of detritus since the inner parts of the reef were formed; and there is some evidence that this was the case, though to what distance, we cannot definitely state. With this admission, the facts may still surprise us; yet they are explained on the principle that fresh water does not sink in the ocean, but is superficial, and runs on in a distinct channel; its effect is almost wholly through hydrostatic pressure, and detritus depositions. Besides these instances, there are many others in the Feejees, as will be observed on the Expedition charts. Mokungai has a large harbor, without a stream of fresh water;—so also Vakea, and Direction Island.

The instances brought forward are a fair example of what is to be found throughout coral seas; and they establish, beyond dispute, that while much in harbor-making should be attributed to the transported sand or earth of marine and freshwater currents, in preventing the growth of coral, but little is due to the freshening influence of the streams of the islands.

But while observing that currents have so decided an influence on the condition of harbors, we should remember another prevalent cause, already remarked upon, and perhaps more wide in its effects than those just considered. I refer to the features of the supporting land, or the character of soundings off a coast. We need not repeat here what has already been dwelt upon, showing that many of the interruptions of reefs have thus arisen. The wide break off Matavai may be of this kind. The widening of the inner channel at Papieti, forming a space for a harbor, may be another example of it; for the reef here extends to a greater distance from the shores, as if because the waters shallowed more gradually outward off this part of the coast. The

same cause—the depth of soundings, on the principle that corals do not grow where the depth much exceeds a hundred feet—has more or less influence about all reefs in determining their configuration and the outlines of harbors. A remarkable instance of the latter is exemplified in the annexed chart of Whippey harbor, Viti Lebu, reduced from the chart of the Expedition to the scale of half an inch to the mile.



WHIPPEY HARBOR, VITI LEBU.

The existence of harbors should therefore be attributed, to a great extent, to the configuration of the submarine land; while currents give aid in preventing the closing of channels, and keeping open grounds for anchorage. This subject will be further illustrated in the following pages.

The permanency of coral harbors follows directly from the facts above presented. They are secure against any immediate obstruction from reefs. Any growing patches within them may still grow, and the margins of the enclosing reefs may gradually extend and contract their limits; yet only at an extremely slow rate. Notwithstanding such changes, the channels will remain open, and large anchorage grounds clear, as long as the currents continue in action. Coral harbors are therefore nearly as secure from any new obstructions as those of our continents. The growing of a reef in an adjoining part of the coast may in some instances diminish or alter the currents, and thus prepare the way for more important changes in the harbors; but such effects need seldom be feared, and results from them would be appreciable only after long periods, since the growth of reefs is very slow in the most favorable circumstances.

When channels have a bottom of growing coral, they form an exception to the above remark; for as the coral is acted upon by no cause sufficient to prevent its growth, the reef will continue to rise slowly towards the surface.

Again, when the channels are more than twenty fathoms in depth, they have an additional security beyond that from currents, in the fact that corals will not grow at such a depth. The only possible way in which such channels could close, without first filling up by means of shore material, would be by the extension of the reef from either side, till they bridge over the bottom below. But such an event is not likely to happen in any but very narrow channels.

In recapitulation, the existence of passages through reefs, and the character of coral harbors may be attributed to the following causes:

1. The configuration and character of the submarine land;—corals not growing where the depth exceeds certain limits, or where there is no firm basement for the plantation.

2. The direction and force of marine currents with their transported detritus;—these currents deriving their course, as in other regions, from the features of the land, the form of the sea-bottom and the reefs, and being sometimes increased in force by the contributions of island streams, which add to the detritus and to the weight of accumulating waters.

3. Harbors which receive freshwater streams or submarine springs of freshwater, are more apt to be clear from sunken patches; and the same causes keep open shallow passages to the shores, where there are shore reefs.

It should be remembered, that while the effects from freshwater streams are so trifling around islands, they may be of very wide influence on the shores of continents, where the streams are large and deep, and transport much detritus. This point is illustrated beyond.

b. Atoll Reefs.—The remarks in the preceding pages respecting reefs around other lands, apply equally to atoll reefs. There are usually currents flowing to leeward through the lagoon, and out, over or through the leeward reef, and this action, as with the coral harbor, tends to keep open a leeward channel for the passage of the water. This is the common explanation of the origin of the channels opening into lagoons. These currents are strongest when the windward reef is low, so as to permit the waves in some parts to break over it; and the coral debris they bear along will then be greatest. When a large part of the leeward reef is under water, or barely at the water's edge, the waters may escape over the whole, and on this account we sometimes find large reefs without any proper channels. As the land to windward becomes raised throughout above the sea, and forms a continuous line which the waves cannot pass, the current is less perfectly sustained, being dependent entirely upon the influx and efflux of the tides; and the leeward channels, in such a case, may gradually become closed.

The action of currents on atolls is, therefore, in every way identical with what has been explained. The absence of coves of land to give force to the waters of currents, and to direct their course, and the absence also of freshwater streams, are the only modifying causes not present. It is readily understood, therefore, why lagoon entrances are more likely to became filled up by growing coral, than the passages through barrier reefs.

3. *Rate of Growth of Reefs.*

The formation of a reef has been shown to be a very different process from the growth of a zoophyte. Its rate of progress is a question to be settled by a consideration of many distinct causes, and the rapid voyage of an Expedition affords no opportunity for definite conclusions.

a. The rapidity of the growth of zoophytes is an element in this question of great importance, and one that should be determined by direct observation with respect to each of the species which contribute largely to reefs, both in the warmer and colder parts of coral-reef seas.

b. The character of the coral plantation under consideration should be carefully studied: for it is of no little consequence to know whether the clusters of zoophytes are scattered tufts over a barren plain, or whether in crowded profusion. Compare the debris of vegetation on the semideserts of California with that of regions buried in foliage; equally various may be the rate of growth of coral rock in different places. Some allowance should also be made for the shells and other reef relics. The amount of reef rock formed in a given time cannot exceed, in cubic feet, the aggregate of corals and shells added by growth—that is, if there are no additions from other distant or neighboring plantations.

c. It is also necessary to examine into whatever has any bearing upon the marine or tidal currents of the region—their strength, velocity, direction, where they eddy, and where not, whether they flow over reefs that may afford debris or not. All the debris of one plantation may sometimes be swept away by currents to contribute to other patches, so that one will enlarge at the expense of others. Or, currents may carry the detritus into the channels or deeper waters around a coral patch, and leave little to aid the plantation itself in its increase and consolidation.

d. The course and extent of fresh waters from the land, and their detritus, should be ascertained.

e. The strength and height of the tides, and general force of the ocean waves, will have some influence.

Owing to the action of these causes, barrier reefs enlarge and extend more rapidly than inner reefs. The former have the full action of the sea, and are farther removed from the deleterious influences which may affect the latter.

As stated above, no results were arrived at from observations made in the course of the voyage through the Pacific. The general impression that their progress is slow, was fully sustained. The facts, with regard to the growth of zoophytes, give some data, though by no means satisfactory.

If we allow that Madrepores may grow three inches a year, it is far from admitting that a reef may increase as rapidly. In the best coral plantations, not over one-third of the surface is covered with growing zoophytes. It would therefore follow, supposing all the species to grow at this rate, and all the material to be retained on the plantation, that in twelve months the reef might possibly increase one inch in height; including shells and other animal remains, it might, perhaps, be one and one-quarter inches. This estimate is based on too many assumptions to be received with any confidence, except it be the confidence that the result is overrated.

With reference to this subject, by the order of Captain Wilkes a slab of rock was planted on Point Venus, Tahiti, and by soundings, the depth of Dolphin shoal, below the level of this slab, was carefully ascertained. By adopting this precaution, any error from change of level in the island, was guarded against: the slab remains as a stationary mark for future voyagers to test the rate of increase of the shoal. Before, however, the results can be of any general value towards determining the average rate of growing reefs, it is still necessary that the growing condition of the reef should be ascertained, the species of corals upon it be identified, and the influence of the currents investigated which sweep in that direction out of Matavai bay.

The depth to which Chamas or Tridacnas lie imbedded in coral rock, has been supposed to afford some data for estimating the growth of reefs. But Mr. Darwin rightly argues that these molluscs have the power of sinking themselves in the rock, as they grow, by removing the lime about them. They occur in the dead rock,—generally where there are no growing corals, except rarely some small tufts. If they indicate anything, it must be the growth of the reef rock, and not of the corals themselves. But the shore-platform where they are found is not increasing in height. They resemble, in fact, other saxicavous molluscs, several species of which are found in the same seas, some buried in the solid masses of dead coral lying on the reef. The bed they excavate for themselves is usually so complete that only an inch or two in breadth of their ponderous shells are exposed to view. Without some means like this of securing their habitations, these molluscs would be destroyed by the waves; a tuft of byssus, however strong, which answers for some small bivalves, would be an imperfect security against the force of the sea for shells weighing one to five hundred pounds.

ART. VII.—*Notices of Botanical Literature, &c.*, in a letter to one of the Editors; by A. GRAY.

My Dear Sir :—I shall be glad to make up for past remissness, and redeem my promises as far as I now may, by sending you some off-hand notes upon botanical matters, whether bibliographical or personal; if you will kindly receive them just as they are recalled to my memory, or as the books I wish to mention are presented to my notice. If I can thus give to the readers of your excellent Journal, interested in such topics, some general idea of what has been doing in the botanical world for a year or two past, or is now in progress, my whole object will be attained. Writing without memoranda, or any definite order, I shall doubtless omit much that should be mentioned, even of what may have fallen under my personal observation.

Having Systematic Botany principally in view, at present, I naturally begin with the most important general systematic work now in progress, viz., *De Candolle's Prodromus*. Nothing has been published since the second part of the 13th volume, in the spring of 1849, (which was duly noticed in your Journal at the time,) not even the prior part of this 13th volume, reserved for the remaining *Corolliflorœ*. Botanists will be glad to learn, however, that the *Solanaceœ*, which Prof. Dunal has kept them so long waiting for, are actually printing off, or are by this time entirely printed. The genus *Solanum* is said to exceed even Senecio in the number of its species, which one would hardly have thought, especialy since so many appear to be cosmopolite. The *Plantaginaceœ*, by Prof. Decaisne, will complete that volume, and the series of *Corolliflorœ*. Meanwhile the 14th volume must be in a state of forwardness, though probably none of it is yet printed; for Prof. Meisner of Basle has already worked up the *Polygonaceœ* (excepting the *Eriogoneœ*, which are done by Mr. Bentham), and I believe also the *Thymelaceœ*, *Proteaceœ*, and their immediate allies. I know not who is to attempt the *Laurineœ*.

Botanists cannot but be grateful to Prof. Alphonse De Candolle, for his strenuous and so successful endeavors to carry on the formidable work bequeathed to him, involving as it does a vast amount of labor and care, and offering no pecuniary advantage, since the recent revolutionary times in Europe; and all will regret, but not be surprised to learn, that it is determined to close the Prodromus at the end of the *Exogenæ* or *Dicotyledones*, of which only a small number of orders, some of them very difficult ones, now remain.

Prof. Alph. De Candolle himself is much occupied with an extended treatise of the geographical distribution of plants he has

long had in preparation; and has recently published two brief but important articles bearing upon this subject. One of them, "Sur les causes qui limitent les espèces végétales du côté du nord, en Europe et dans les régions analogues," communicated to the French Academy of Sciences, (published in *Ann. Sci. Nat.*, for Jan., 1848,) deduces the law, that each species having its polar limit in central or northern Europe, extends as far northward as it receives a certain fixed amount of heat, calculated (not from the mean temperature of the year but) between the day when there commences and the day that ends a certain mean temperature. The other, "Du mode d'action de la chaleur sur les Plantes, et en particulier de l'effet des rayons solaires" (*Bib. Univ. Genève*, March, 1850), investigated by making growing plants themselves serve as the measure of solar action, goes to show that Boussingault's method of estimating the sum of heat necessary to produce a certain result in a given species, requires still further modification; and that, as might be inferred, the effect of the sun on the thermometer, is far from being a true measure of its action on vegetation.

Shortly after the lamentable death of Prof. Kunth* (which occurred on the 22d March, 1850, at the age of 62), appeared the fifth volume of his *Enumeratio Plantarum*, comprising the Orders *Asparagineæ*, *Smilaceæ*, *Dioscoreaceæ*, and *Amaryllidaceæ*, with some small groups nearly allied to these. Its merits appear to be about the same as of the preceding volumes.

The *Annales Botanices Systematicæ* of Walpers, has not gone beyond the first volume.

Since Endlicher's death, a fifth supplement to the *Genera Plantarum*, or rather a continuation of the fourth supplement, part 2, has been published, from MSS. left by Endlicher and completed by Dr. Fenzl. It is announced on the cover that no MSS. for the first part of this fourth supplement were found. Endlicher's professorship in the Vienna University is divided between Dr. Fenzl, who has also the charge of the Imperial herbarium, and Dr. Unger, of Gratz, the historian of fossil plants, who takes the anatomical and physiological department.

Under the title of *Die Urwelt in ihren Verschiedenen Bildungsperiod* (*Le Monde Primitif à ses differentes époques de Formation*), Prof. Unger has just published a series of fourteen landscape plates, in imperial folio, of high artistic merit as well as scientific interest, representing a scene from each principal geological period, designed especially to reproduce the vegetation; accompanied by forty pages of explanatory text, German and

* A biographical memoir of this distinguished botanist, from the hand of M. Adrien de Jussieu, will be found in the *Annales des Sciences Naturelles*, No. 2, for 1850.

French, in parallel columns. The plates were executed at Munich, in lithography, of the very highest excellence. In this connection, I may call your attention to a highly interesting memoir by Prof. Adolphe Brongniart, in *Ann. Sci. Nat.*, for May, 1849, but not published before nearly the close of that year, entitled, *Exposition Chronologique des Périodes de Végétation, et des Flores diverses qui se sont succédé a la surface de la Terre.* If some one would take the trouble to make a translation, it would be interesting and useful to reproduce it in your Journal. From the vast predominance in the most ancient formations of Acrogenous Cryptogams (*Ferns* and *Lycopodiaceæ*), succeeded at length by Gymnospermous Dicotyledons (*Cycadeæ* and *Coniferæ*), and from the first appearance in later times, and soon the predominance of Angiospermous Dicotyledons and Monocotyledons, M. Brongniart is led to arrange the floras of the ancient world, considered as to their succession in time, under three great dynasties, viz.,

(1.) *The Reign of Acrogens.*
1. Carboniferous Period.
2. Permian Period.

(2.) *The Reign of Gymnosperms.*
3. Vosgien Period.
4. Jurassic Period.

(3.) *The Reign of Angiosperms.*
5. Cretaceous Period.
6. Tertiary Period. (Each period divided into its several epochs.)

Prof. von Martius having brought to a close his great work on the *Palms*, in three elegant folio volumes, in a style and form commensurate with the grandeur of the subject—a work which requires a separate and detailed notice—he is now enabled to turn his attention again to the *Flora Brasiliensis*, which is now likely to go on, although I am not aware that a new part is actually in press.

The *Genera Floræ Germanicæ Iconibus Illustrata*, begun by Th. F. L. Nees von Esenbeck, and after his death transferred to Prof. Spenner of Friburg in Briesgau, and after his death continued by Endlicher and Dr. Putterlich of Vienna, since the death of both of the latter botanists, has been taken up by Prof. Bischoff of Heidelberg, who is as accomplished a draughtsman as a botanist. I have seen some of his illustrations of *Umbelliferæ*, which will more than sustain the character of this work, but I am not sure whether any new fasciculi have yet been issued.

The recent mortality among the German botanists is very remarkable. Besides those already mentioned, are the following. The veteran Prof. Link, died at Berlin on the 14th of January last, at the age of 85, active almost to the last, and surviving

almost a year his unfortunate colleague, Prof. Kunth, as well as his colleague in the Flora of Portugal, Count Hoffmansegge. Prof. Hornschuch of Griefswalde, the eminent muscologist, died on the 7th of January last, also, I believe of advanced age. Prof. Bernhardi of Erfurt, died in May, 1850, aged 76. Prof. Koch of Erlangen, author of the *Flora Germanica*, and long esteemed the best authority in German plants, died in November, 1849, aged 78. In the same month and of the same age, died Dr. Sturm, the Cryptogamist, at Nuremberg; and in the month previous, Prof. Schauer, of Breslau. Prof. Kunze of Leipsic was suddenly struck down by apoplexy, on the last day of April, 1851. Prof. Ledebour, died at Munich on the 4th of July last.

The professorship at Berlin, with the curatorship of the Royal Botanic Garden, having been declined by Prof. Mohl, who was unwilling to leave Tubingen, has been accepted by Prof. Braun, who had shortly before been transferred from Friburg to Giessen, but who will now find fuller scope for his activity and great talents at the Prussian capital. Dr. Mettenius of Heidelberg has been appointed to the chair at Friburg. The chair of the late Prof. Kunze has been assigned, at least for the present, to Prof. Pœppig, the South American traveller.

The distinguished Professor Wahlenberg of Upsal, died on the 23d of March, only a little above seventy years of age; and is succeeded by the celebrated Fries, who has until now held some minor professorship in the University of Upsal, not connected with botany. Prof. Fries has recently published a second part of the *Summa Vegetabil. Scandinaviæ*, and also (in the Upsal Transactions) an elaborate monograph of Hieracium, a genus which gives no small trouble to European botanists.

Ledebour's *Flora Rossica* had been continued down to the end of the Dicotyledones previous to the author's decease; and it is understood that the manuscript for the remainder is very nearly complete.

Mr. Webb, having finished his elaborate *Phytographia Canariensis* during the past year, the splendid *Histoire Naturelle des Iles Canaries*, par MM. P. Barker Webb and S. Berthelot, is now, I believe, complete. The principal labor has fallen upon Mr. Webb himself, Mr. Berthelot having long been absent from France, on a distant colonial appointment. The botanical portion of this great work consists of four volumes (imperial 4to) with 287 plates; besides the volume on Geographical Botany, treating of the general aspect of the vegetation of the Canary Islands, its phytostatic distribution, &c.

Dr. Weddell, one of the more distinguished of the younger botanists of Paris, though an Englishman by birth, now one of the aid-naturalists at the *Jardin des Plantes*, has made a most important contribution to materia medica as well as botany, in

his splendid folio *Monograph of Cinchona*,* the result, in part, of a two years' exploration of the peruvian-bark forests of Bolivia and Peru. Dr. Weddell went to South America with M. Castelnau (who was well known to the naturalists of the United States a dozen years ago), and explored with him the interior of Brazil; but leaving that party on the borders of Bolivia in 1845, he devoted himself to this special undertaking until his return to Europe early in 1848. Dr. Weddell is now on a second visit to the same regions. The introduction to his treatise comprises an interesting historical sketch of the principal scientific journeys undertaken into the regions that furnish Peruvian bark, by Condamine, Joseph de Jussieu, Mutis, Ruiz and Pavon, Humboldt and Bonpland, &c., followed by his own itinerary, and an account of the mode in which the bark is sought, gathered, and prepared by the *Cascarilleros*. Then follows the detailed monograph of the genus Cinchona, the anatomy of the bark, and the general characters of all the organs; the geographical distribution of the genus; the detailed history and characters of the species known to the author, nineteen in number, and of the respective products of those which furnish the different barks of commerce.† Dr. Weddell separates all the former Cinchonæ which have the fruit

* *Histoire Naturelle des Quinquinas, ou Monographie du genre Cinchona, suivie d'une description du genre Cascarilla et de quelques autres plantes de la même tribu;* par M. H. A. Weddell, Docteur en Mèdecine. Accompagné de 34 planches, dessinées par Riocreux et Steinheil. Paris: Victor Masson. 1849. (60 francs.)

† It appears that the *cinchonine* is contained principally in the cellular, and the *quinine* in the fibrous, tissue of the living bark, although the most fibrous specimens are not the richest in the latter principle, and the value of a given kind of bark may be judged, to a certain extent, by the appearance of the fracture. Dr. Weddell distinguishes three modifications of fracture; the *corky*, the *fibrous* and the *filamentous* (*filandreuse*), of which the latter indicates a greater richness in quinine than the first, but less than the second. The gray barks, Dr. Weddell shows, are not derived from distinct species, but from the young branches of several different species, the older stems of which furnish red or yellow barks. The *Gray Barks* of Loxa, or *Crown Barks*, are yielded by *Cinchona condaminea*, *C. scrobiculata*, and *C. macrocalyx*. The *Silver Barks*, or *Gray Barks* of Lima or Huanuco, come from *C. micrantha* or *C. lanceolata* and *C. glandulifera*. The *Red Barks* of Lima are yielded by *C. nitida;* the red and brown bark of Carthagena are of uncertain origin. The principal *Yellow Barks* come from *C. Calisaya* of Weddell; the *Orange-Yellow* from *C. micrantha;* the *Woody Carthagena Bark* and *Quinquina Pitaya*, from *C. condaminea;* and the *new spurious Yellow Bark* of Pereira, from *C. lancifolia*. The *Rusty Barks* of Humalies are furnished by *C. hirsuta*, *C. micrantha*, *C. ovalifolia*, and perhaps *C. purpurea*. The *White* or *Ash Barks* of Loxa, &c., come from *C. ovata;* those of Cusco and Arica from *C. pubescens* or *C. ovalifolia*. *Cinchona Calisaya*, *condaminea* and *nitida*, appear to yield the richest kinds of bark.

As to geographical distribution, the genus Cinchona occupies a narrow, ribbon-shaped tract, 29 degrees of latitude in length, and curved, according to the general direction of the Andes, into an arc, with its convexity looking westward, the centre and most westerly part of which is at Loxa. Nearly the whole of it is on the Atlantic slope of the Andes, and it corresponds in a remarkable manner with the innumerable sources of the Amazon. The southern limit is in Bolivia, at lat. 19° S.; the northern at Venezuela, in lat. 10, not far west of Porto Cabello. As to elevation, the Peruvian bark forests are comprised within the extremes of 1200 and 3270 metres.

dehiscent from the apex downwards; the principal part of them forming his genus *Cascarilla*, of which a monograph is subjoined. These *false quinquinas* are distinguished by the greater astringency of their bark, which is destitute both of *Quinia* and *Cinchonia*. The illustrations consist of a view in the Cinchona forest of the valley of *San Juan del Oro*, in Peru, of two plates filled with details of anatomical structure, twenty-three plates exhibiting the species of Cinchona, and five, those of allied genera; three colored plates represent the principal kinds of Peruvian bark, in a very beautiful manner; and a map of the intertropical Andes shows the geographical distribution of the Cinchona forests.

During the past year Mr. Weddell has contributed to the *Annales des Sciences Naturelles*, a remarkable paper on the structure of the *Balanophoreæ* as compared with *Rafflesiaceæ*, the theoretical conclusions of which are more ingenious perhaps than sound.

The appointment of M. Decaisne to the chair of Culture at the *Jardin des Plantes* (as the successor of M. Mirbel, who still survives, although extremely and hopelessly infirm), to the duties of which he is devoting himself with characteristic energy and success, has to a great degree, turned his attention, though only temporarily, it is hoped, from systematic botany.

The ill-health of Prof. Adrien de Jussieu has prevented him from engaging of late in any extensive botanical work, like that upon the *Malpighiaceæ;* but with renovated health, new researches may be expected from this most learned and skillful botanist. M. Gaudichaud, notwithstanding his infirm health, is about to bring to a conclusion the Botany of the Voyage of the Bonite, which, by the contract of the publisher with the Minister of Public Instruction, must be finished at the close of the current year. A large number of plates have already been issued, but without any letter-press of the systematic part; and that veteran and most active cryptogamist, Dr. Montagne, has already completed the cryptogamic portion. The small portion of letter-press already published by Prof. Gaudichaud relates almost exclusively to his theoretical views of vegetable structure, in illustration of which he has formed a cabinet of extremely interesting materials.

Dr. Montagne, who is remarkable for promptly carrying through the work he undertakes, has also completed the Cryptogamic Botany of the Voyage of the Astrolabe and Zelée (D'Urville's); while of the Phanerogamic part, nothing has appeared beyond an atlas of plates, wholly destitute of letter-press.

Of the aid-naturalists at the *Jardin des Plantes*, the principal are M. Weddell, now temporarily absent in South America (as already mentioned); M. Spach, who still goes on with the *Illustrationes Plantarum Orientalium*, in connection with Count Jaubert; M. Naudin, who is sedulously working up in monographs

all the *Melastomaceæ* of the Herbarium; and M. Tulasne, who has newly elaborated the *Podostemaceæ* (in 20 genera); and whose researches in vegetable embryogeny, and discovery of *Antheridia* in Lichens, require a notice on another occasion.

M. Claude Gay is still carrying on his elaborate *Historia Fisica et Politica de Chile*, and working up himself a considerable part of the botanical as well as the zoological portion. Of the Flora of Chili four volumes (8vo,) are completed, and half of the fifth volume, extending into the Monochlamydeæ. Also of the seventh, the Cryptogamic volume, the indefatigable Dr. Montagne has brought out two parts, comprising the Musci and a portion of the Hepaticæ. The technical characters are given in Latin, the detailed descriptions and the observations are in Spanish. It is illustrated by an atlas of admirable plates (in short folio,) from drawings by Riocreux, the most accomplished of botanical draughtsmen. The work, a truly national one, is sustained, in great part, by Chilian subscribers. One of M. Gay's best collaborators, M. Remy, after elaborating the Compositæ for this work (in a manner on the whole very creditable,) has been sent, by the administration of the museum, to make a botanical investigation of the Sandwich Islands.

In the death of M. Benj. Delessert science has lost a most enlightened and liberal patron; but it is pleasant to know that the unrivalled library and rich herbarium, and whole scientific establishment are kept up as aforetime, in the Rue Montmatre, by his excellent brother, M. François Delessert; and M. Lasègue the curator is still in daily attendance upon the botanists who flock there to consult these precious collections.

Prof. Richard has made some further progress of late with the botanical part of Ramon de la Sagra's *Historie Physique Politique et Naturelle de l'Ile de Cuba*, (that is, with the *Plantes Vascularaies;* the *Plantes Cellulaires* having long since been completed by Dr. Montagne;) and he has just finished his *Flore de l'Abyssinie* (2 vols. 8vo, with a folio atlas).

M. Boissier, of Geneva, had brought out eleven parts of his *Diagnoses Plantarum Orientalium*, the result, principally of his own explorations in the East, when he was interrupted by a grevious domestic affliction. His extensive herbarium has lately been much increased by the purchase of the herbarium of Pavon, rich in American plants, in complete and well-preserved specimens. It was purchased in Spain, through the instrumentality of his colleague and curator, M. Reuter.

Prof. Choisy of Geneva is occupied with a revision of the *Guttiferæ:* M. Duby, with the lower Cryptogamus plants, and with a new edition of the *Synopsis Floræ Galliæ et Helvetiæ.* Prof. Godet of Neuchatel is engaged upon a Flora of the Jura; and Mr. Shuttleworth, of Berne, with the fine collections of Florida and Key West plants sent him by Rugel.

Prof. Lehmann of Hamburgh is engaged upon a new and fuller monograph of *Potentilla*, a genus upon which he has written so much, and of which he has accumulated the amplest materials. Meanwhile he has given, in his ninth *Pugillus Novarum et Minus Cognitarum Stirpium* (1851), a revised arrangement, with a complete catalogue and synonymy of all the species at present known, 193 in number.

Dr. Blume, the director of the Royal Herbarium at Leyden, having finished the *Rumphia* (in four folio volumes, with 213 plates) is making arrangements to resume his *Floræ Javæ*, which was interrupted in 1829, with the third volume. He also began in 1849, and continues in monthly fasciculi, each of 16 pages 8vo, the "*Museum Lugduno-Batavum, sive Stirpium Exoticarum Novarum vel minus Cognitarum ex vivis aut siccis brevis Expositio et Descriptio, additis figuris.*" Each number is accompanied by one plate, giving the detailed generic characters of from two to four plants. Different families or groups are taken up in succession, and more or less revised or monographed.

Professor DeVriese, who now has the botanical chair in the University, and the direction of the fine old botanic garden of Leyden, and Prof. Miquel, who holds the same position at Amsterdam, besides other important scientific undertakings, are working up the large collections recently brought by Junghuhn from the Dutch East India possessions, assisted by several collaborators (Mr. Bentham taking the *Leguminosæ*, etc.): the first fasciculus of the *Plantæ Junghuhnianæ* has already appeared, and probably the second also.

Drs. Dozy and Molkenboer, two physicians of Leyden, occupy their leisure with the Muscology of the Dutch Colonies.

Last year Sir Wm. Hooker, in conjunction with Professor Arnott of Glasgow, issued a new (the sixth) edition of the *British Flora*, which by the use of small type is brought down from the 8vo to a compact 12mo size. And Mr. Babington has this year brought out a third and revised edition of his *Manual of British Botany*. These two works ably represent the rival schools; the one strongly inclined to *combine and reduce*, the other to *distinguish* species.

Sir Wm. Hooker, although much absorbed with the direction of the noble botanic gardens at Kew, (which are on a scale worthy of the British nation, and which he has brought to a high state of perfection*) and with the editorial care of the *Botanical*

* Among the additions and improvements which have so changed the whole appearance of this establishment, that the visitor of twelve years ago scarcely recognizes the place, we should not omit to mention the great *Palm-house*, completed in 1848, in which the magnificent collection of palms and other large tropical trees and shrubs are now flourishing in all the freedom and luxuriance of their native climes. This structure is 362 feet in length, the central part 100 feet wide and 66

Magazine and of his *Journal of Botany*, has at length resumed the publication of his *Species Filicum;* part five, the first part of the second volume, having been issued last summer. It commences his fourth suborder, *Pterideæ*, (coinciding with the *Adiantaceæ* of Presl,) and is chiefly occupied with the genus *Adiantum*.

He has also resumed, with Reeve and Benham for publishers, his *Icones Plantarum*, which H. Bailliere threw up three years ago, at the close of the eighth volume. It is now issued in monthly numbers (at 2*s*. 6*d*.), each number containing eight plates. Even now it is doubtful whether it can be kept up, although the drawings are furnished on the stone gratis to the publisher, who has only to work them off, and print the small quantity of letter press required. But the sale of scientific periodicals, and indeed of most scientific publications in Great Britain, is inconceivably small. We must not forget Sir Wm. Hooker's magnificent publication brought out last spring, on the *Victoria regia*, in elephant folio, illustrated with four plates by Mr. Fitch, in a style worthy of the splendid subject. A new house is building for the Victoria at Kew gardens, with a tank large enough to show this gigantic Water-lily to advantage, and allow of its full development. A successful attempt has lately been made to flower this plant in the open air, at Chelsea, near London; the pond, however, being artificially warmed by hot water pipes; but this, as Mr. Downing remarks in the Horticulturist, would probably be unnecessary in the United States. Even at the north, our sultry summer's sun might heat a shallow pond sufficiently to bring well into flower vigorous individuals planted out in June or July.*

A second part of Dr. J. D. Hooker's superb *Rhododendrons of Sikkim Himalaya*, (illustrating ten more species,) was published last spring, about the time of the return to England of this ardent explorer and accomplished naturalist, from the field where he has been gathering so many laurels;—and even a third is now nearly ready.

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feet high; it is covered by about 45000 square feet of glass, all set in iron, and heated by 24000 feet of hot-water pipes, and a thousand square feet of tanks. And also the *Museum*, which the director has recently established, and which "is destined to receive all kinds of fruits and seeds, gums, resins, dye-stuffs, drugs, sections of woods, and all curious vegetable products, especially those that are useful in the arts, in medicine, and in domestic economy." This collection is rapidly increasing in extent and value; and it is already one of the most attractive and instructive portions of this great scientific establishment.

* Since this was written we learn that a plant has grown well in such a situation, in the kitchen garden of Mr. Cope, the president of the Pennsylvania Horticultural Society; but having been raised from the seed since the 21st of March, it was not sufficiently developed to flower this season. A plant of the same age, grown in a tank, kept at the proper temperature, opened its first blossom on the 21st of August. See *Downing's Horticulturist* for October.

Dr. Hooker has brought home vast botanical collections, as well as an immense number of drawings, &c. His former schoolfellow, Dr. Thompson (son of the distinguished chemical professor at Glasgow, and his companion during the latter part of his exploration,) has also amassed an equally extensive herbarium in other parts of India, chiefly in the eastern Himalayan region. These, with the Wallichian and other herbaria, will serve as the foundation for the *Flora Indica*, which, should some aid be secured from the government and the East India Company, these courageous and excellent botanists propose to undertake. Meanwhile Dr. Hooker is already actively engaged with his *Flora Novæ-Zeelandiæ*, which, followed by the *Flora Tasmaniæ*, (both after the model of his *Flora Antarctica*,) will complete the botany of the Antarctic voyage under Capt. Sir James Ross.

When Dr. Hooker left England for India, he was engaged in working up the collections made by the lamented Dr. Vogel, in the ill-starred Niger expedition, under Capt. Trotter. The *Niger Flora* from the *Leguminosæ* onward was therefore elaborated by Mr. Bentham; and the *Spicilegia Gorgonica. a Catalogue of all the Plants as yet discovered in the Cape de Verd Islands*, with many important botanical details and characters, contributed by Mr. Webb; and the whole illustrated by fifty plates. A biography of Dr. Vogel, translated from the German of Dr. Treviranus, in the *Linnæa*, and his Journal of the voyage, up to the time of his fatal illness, preface the volume.

The directors of the East India Company are distributing among botanists copies of the journals and posthumous papers of the late Mr. Griffith, printed at Calcutta. Unfortunately the editor appears not to know enough of botany to correct the most obvious slips of the pen or mistakes of the press, nor to omit mere crudities and rough guesses, placed upon paper only to aid the memory, and obviously as unfit for publication, as are the occasional remarks, reflecting offensively upon other botanists. Two volumes of journals and itineraries have been issued; one on the development of organs in Phanerogamous plants; and one of notes on the development and structure of the higher Cryptogamous plants; each of the latter with a large quarto atlas of plates.

After an interval of four years a new part of the *Transactions of the Linnæan Society of London*, (part 3 of vol. xx,) has been issued. The greater number of papers, as is to be expected, are botanical. Prof. Arnott has a "*Note on Samara læta of Linnæus*, which proves to be a Myssinaceous plant, congeneric with Choripetalum. Mr. Miers contributes *a new genus of the order Burmanniaceæ*, with an arrangement of the family. Mr. Kippist describes "*Jansonia* a new genus of Leguminosæ," which proves to be identical with Cryptosema, *Meisn.* The late Mr.

Griffith has a paper on the *Structure of the Ascidia and Stomata of Dischidia*, and one *On the Impregnation of Dischidia*. These, with a paper *On the Development of Lemanea fluviatilis*, by Mr. Thwaites of Bristol, (now the successor of the lamented Dr. Gardner at Ceylon,) belong to the department of Structural Botany. Dr. Falconer describes *Athalamia, a new genus of Marchanticæ*. Dr. Planchon gives a detailed memoir *On Melianthea, a new natural order*. And finally Mr. Brown has published his account of that beautiful and perfectly preserved fossil fruit (*Triplosporite*, so called from the remarkable development of the spores in threes instead of fours,) which he has for several years past shown to those interested in such researches. If not identical, it is certainly very closely related to *Lepidostrobus*, which is thus demonstrated to be a Cryptogamous plant, allied to Lycopodium. An admirable paper of Dr. Hooker's on the structure and affinities of *Lepidostrobus*, we may add, which arrives at the same conclusion, may be found in vol. ii, part 2, of the *Memoirs of the Geological Survey of Great Britain*, accompanied by one *On the Vegetation of the Carboniferous period, as compared with that of the present day*, and another *On the Structure of Stigmaria*.

In Cryptogamic botany many new systematic works have appeared, and nearly all the orders have been newly elaborated.

We know of no proper *Species Filicum* in progress, except Sir Wm. Hooker's, already noticed.

The late Prof. Kunze's supplement to Schkuhrs Filices, (*Die Färnkrauter in koloriten Abbildungen*,) has gone only to the fourth fasciculus of the second volume, published last spring.

The *Synopsis Hepaticarum* by Gottsche, Lindenberg, and Nees von Esenbeck, gives full characters of all the species known up to 1847, when the last (fifth) part was published; the whole forming an 8vo volume of 834 pages. The genera, as well as the species are largely increased; and the former, 72 in number, are disposed in five tribes.

A similar work on the true Mosses, the *Synopsis Muscorum Frondosorum omnium hucusque cognitorum*, by Karl Müller, is by this time almost completed. The latest portion received (the third fasciculus of the second volume,) finishes the great genus *Hypnum*, of which 500 species are described.

The latest part of the admirable *Bryologia Europea*, with the authorship of which the name M. Gümbel is lately associated, is, I believe, the 42nd (1849). And Dr. Schimper has lately published in the *Mémoires de la Société d'Hist. Nat. de Strasbourg*, an elaborate paper on the anatomy and development of Mosses.

Kützing's *Species Algarum* (1849) has been followed, or rather superseded, by the much sounder *Species, Genera, et Ordines Algarum, seu Descriptiones succinctæ speciorum, generum, et or-*

dinum quibus Algarum regnum constituitur, by J. G. Agardh. The first part of the second volume appeared in July last. It is published at Lund, (Sweden,) and at Leipsic.

We should not forget here to state that the accomplished algologist, Professor Harvey, has completed the third volume of his admirable *Phycologia Britannica*, which finishes the work. The 360 plates represent 378 species. A full synopsis of the orders, genera and species is appended, and new title-pages and indexes are given, arranged for binding the work either in three volumes, according to the order of publication, or in four, systematically, according to the synopsis of the species. The cultivators and amateurs of our science may be interested to know that Professor Harvey is now engaged upon his extensive memoir on the North American Algæ, to be published under the auspices of the Smithsonian Institution; and the plates of which promise to rival or excel those of the Phycologia Britannica, or of his *Nereis Australis*, which are so justly admired. The first part, containing the olive series of sea-weeds, is now in press. The new edition of his *Manual of British Algæ*, or rather a new work, the *Manual of the British Marine Algæ*, was issued by Van Voorst at the close of 1849, during the author's visit to this country. The genera are illustrated by twenty-six plates, after the manner of Dr. Greville's well-known *Algæ Britannicæ*.

Schærer's *Enumeratio Critica Lichenum Europæorum ex nova Methodo, &c.*, (Berne, 1830, 8vo, with 10 plates), is the latest and most important general work upon this order.

ART. VIII.—*Views on the Nature of Organic Structure;* by Lieut. E. B. HUNT, Corps of Engineers, U. S. A.*

THROUGHOUT the whole range of organic existence, both animal and vegetable, there is an evident adaptation of species and individuals to the particular circumstances in which they are found. Nor is it less true, that all animals and vegetables exhibit a broad general adaptation to the great cosmical and chemical peculiarities of the earth itself. The conditions indispensable for the existence of each organic species are such, that we cannot imagine its vital possibility except in its present astronomical *habitat*. Any great change from the earth's values for gravitation, the atmospheric pressure, the average heat and light, or greatly increased variations in these elements of condition, would prove fatal to all our present species. Nor could these species long survive a fundamental change in the atmosphere, the waters, the vapors, or the soils of the present terrestrial system.

* Proc. Amer. Assoc., Albany, 1851. Sent to this Journal for publication, by the author.

The problem of conditions of existence, has an astronomical or cosmical phase. We can conceive a planet with platinum, gold, and silica continents, with a mercurial atmosphere, with elements whose combinations should be a hundred fold more refractory than ours, and yet with temperature conditions such that its aggregates of inorganic matter should be much the same as we now see. Moreover, we can conceive the existence there of vital organic forms, composed of elements wholly different from those entering organic bodies here, but whose functions should be performed exactly in conformity with earthly analogies.

How vastly unlike in physical features are this earth, Neptune, and Mars, yet some kind of organic life is, doubtless, actually existent on each. The structure of material forms, fitted to perform organic functions, involves an idea of the highest generality, and is mechanically possible in an infinity of material conditions. Either the organic form or the *habitat* being given or predetermined, an intellect sufficiently capacious could determine the other by *pure computation*. If to this intellect be superadded the power of giving material form or expression to these computed results, nothing more would be necessary for placing any conceivable organic type in its proper home, or in forming for any home its proper organic inhabitant. Man's intellect quite suffices to conceive how the Divine creative mind might infinitely vary organic forms in simple adaptation to their dissimilar homes throughout this wide universe. The historic order, in forming for all these varieties the terms of the existing relation between home and inhabitant, has been, seemingly, first to arrange the home, and then to construct the inhabitant. The species actually seen around us, embody the Divine solutions of those particular problems furnished by their specific physical circumstances. The range of variation in these circumstances over the earth's surface, permitted that immense variety of specific solutions exhibited by the known animal and vegetable kingdoms.

Certainly, natural science is falsely so called, when it ignores the intellectual character of organic forms. An optician who should attempt to investigate the eye without conceiving it as an intellectually composed organ, might labor forever in vain. The single way to comprehend its structure and mode of agency, is by carefully decyphering those ideas which are embodied and expressed in its forms and composition. Its one object is to form distinct images on the retina, and all its parts are composed with a strict view to the accomplishment of this object. A man who should study hieroglyphics, a locomotive, a telescope, a watch, or a book, in a spirit of mental negation and stubborn imperception of their intellectual origin, would not be more absurd, than one who sees no intellectual designing in the eye, the ear, the nerves, the skeleton, the whole organic frame. So far from its being

unscientific to make a clear and positive use in natural research, of the intellectual character stamped on all organisms, it is simply self-inflicted blindness and deliberate paralysis to ignore those God-thoughts, actually embodied in each vital structure. The meaning and design of these structures are not less real than the matter composing them; just as the design and mental significance of a house are equally real with its materials.

A distinct conception of the intellectual arrangement of organic parts, in themselves, in their connections, and in their external relations, gives a clue to the physical nature of organic structures, such as no other view can give.

Inorganic masses of matter have an unlimited capacity to give expression to ideas, either without motion, as in the fine arts, or with motion, as in machinery of all kinds. In a locomotive, for instance, thousands of ideas, first existing only in the human mind, are materially embodied and formalized through this complex arrangement of parts, all of which act in designed relations. Functions of various kinds are performed in harmonious concurrence, exhibiting a partial semblance to vitality. Man's history proves, that were his intellect a hundred fold greater than it is, machines might be devised which would perform unimagined wonders. Every increase of intellect would give increased capacity to work ideas into material forms. A comparative machinist might, from a machine, infer the mental character and proficiency of its designer, just as a comparative anatomist makes out from the bones of an animal, all its habits. Any designed material structure reflects the intellect of its designer, and becomes higher in character with each exaltation of the designing mind. Were man's intellect to grow towards an infinite stature, where could we draw a limit to his capacity for giving material embodiment to his most advanced ideas? Would not his ever enlarging mind still clothe itself in material forms of proportionate subtlety in structure, function and design?

But man, in erecting material structures, deals only with masses. He has no power to build up his forms, by using at will, and in succession, *single molecules* of each chemical element. Were man's perceptions and capacities so microscopic that he could work with single molecules, and were his intellect sufficiently exalted, he might build up, in a purely mechanical mode, the exact similitude of any existing organic form, even that of his own body. Infinite intellect having wrought out the ideal of man's body, might thus materialize that ideal by simple arrangement of molecules, without the least change in any one molecule, or the introduction of any new mechanical element. To such a structure, the forces constitutional in matter would give coherence and stability. What more is required for conceiving the physical character of an organism, at a given instant of time?

Another step remains to complete our conception of the whole life of organic structures. What then is growth, and how is it to be conceived or explained?

The ideal of an organism extends through its entire cycle of being. The ideal of an oak is not the mere form of to-day, but that aggregate of formal progressions included between the acorn and the decaying oak. It includes provision for everything needed to insure its normal perpetuity. The history of an organic individual or species must always contain the two great elements of original constitution and circumstantial position. The specific ideal is inwrought and formalized in its constitution, while physical circumstances mar or exalt the development of this ideal. Unless an ideal were framed with a foresight of circumstantial influences, it must soon be frustrated. Now it is very possible to conceive how structures, intelligently composed from simple ordinary molecules, may be made to embody both static and dynamic ideals. The forces appertaining to the ultimate units of matter are quite adequate to work out ideals extending over the changes of a lifetime. In all organisms, the normal changes are progressive, and exemplify the law of continuity. This continuity extends unbroken through countless generations, always exhibiting strict conformity to mechanical requisitions. The wheel of specific life rolls steadily on, while its points describe the cycloids of individual life. A present structure may be so composed that the molecular forces acting between its constituent molecules, will of themselves work out a long train of predetermined changes. No matter how complicated the system of molecules may be, the determination of the orbit and movements of each molecule is a strict problem in mathematical mechanics, exactly the same in principle as that of planetary or projectile motion. The vast intellectual difficulty of the discussion does not affect its principle, nor would it obstruct a full predictive insight by a mind of sufficient grasp. Those differential worlds, whose integrals are seen in organic masses, move on, planet-like, in the round of their mechanically determined orbits.

That intellect which was large enough to idealize man, was, doubtless, large enough so to construct his body that the constituent forces of its component matter should operate the observed renovation and progression of its parts. In framing the ideal of which man is the embodiment, not only is it conceivable that the designing intelligence inwrought every mechanical essential for the physical functions of a full-grown man, but that a definite physical provision for all the changes in the whole cycle of his being was incorporated in the structure of his body. The individual cycle of growth, and the physical history of our race, from its beginning far into the unenacted future, may have been struc-

turally embodied in the frames of our created progenitors and in the circumstances of existence surrounding them and their posterity. Thus, too, by direct design may the body have been made the structural depository of all those harmonies which alone can fit it to become the physical home of the spirit which inhabits it.

This mode of viewing organisms furnishes a hint as to instinct. A divine ideal would contain provision for all stages in the development of the individual. The activity of animal faculties is closely connected with, and mainly controlled by, physical structure, which, in all stages of development, must embody the necessary conditions for continued existence. In designing and framing an animal structure, the means for stimulating all the faculties required at each stage of its existence, would be introduced in its bodily constitution. Thus the operations, usually called instinctive, would result from a predetermined structure, specially designed to stimulate the particular faculties exercised. The materialized ideals would determine which faculties would be most active at each stage of growth and in each species of animals.

The views now presented are based entirely on the conceptions of matter and its constitutional forces, which inorganic masses constrain us to adopt. It cannot be too distinctly stated that every mechanical idea is outraged by the common conceptions of a peculiar "vital force" or "organic force." The term "force" has a definite meaning when used in mechanics, but no one can define a vital force. It is too mysterious, fickle, evasive, and illegitimate to permit a clear conception or definition. When an organic process is not understood, a vital force is usually summoned to remove our ignorance out of sight. Never was anything more purely hypothetical. Its parent is ignorance, smothering truth and investigation its office. Until some shadow of evidence is presented, that a special unmechanical force, peculiar to organic bodies really exists, we are in duty bound to abjure this convenient, this elastic figment of a vital force, which, "having no law, is a law unto itself." Though the complication of organic structure may forever prevent a strict mechanical analysis of organisms, we are not thus authorized to hypothecate a new force for convenience in cloaking ignorance. So far as we know, no molecule is ever moved, except by a real mechanical force, nor indeed can be, on account of its inertia. Though our muscles move in obedience to nervous impulses, the agencies applied are doubtless wholly physical below that point, so wholly mysterious, where the nerves centralize into one subtle thread of connection between the spiritual and material part of man.

This glancing into the depths of organic structure is no transcendental flight beyond the actual. Our appeal is only to that intelligence actually exhibited in formalizing the masses which

compose organic studies. Let our conceptions but extend the sphere of this intelligence, to the intimate constitution of each organic mass, and we shall find a new light thrown on the whole nature of organic structure. It is true that every organism, on this view, is an embodiment of more subtle intelligence than all mankind can boast. But he must have studied nature quite in vain, who has not seen compulsory evidence that the organic architect is indeed great.

ART. IX.—*On the Municipal Electric Telegraph; especially in its application to Fire Alarms;* by WILLIAM F. CHANNING, M.D.

THE Electric Telegraph has two distinct offices. The first is to interlink distant communities, and to this its applications have been hitherto chiefly confined. The second which is hardly less important is to bring into coöperation the members or parts of single communities. Just in proportion as Civilization advances this application is to have a larger development. The Electric Telegraph is to constitute the nervous system of organized societies. For purposes of general intelligence and regulation, of alarm and police, the Municipal Telegraph, that is the Telegraph within the City or Town, has already numerous applications, which are of rapidly increasing importance. A single one of these, the application of the Telegraph to signalizing and communicating alarms of fire, with its incidental use for purposes of police, will be the subject of the present paper. The general conditions on which the security and uniform operation of the Telegraph, in all its Municipal applications, depend will also be considered.

At an early period in the history of the Electro-magnetic Telegraph in this country, the writer described its application to Fire Alarms, and published in the Boston Daily Advertiser of June 3, 1845, a general statement of principles which will be here more fully developed, and which are the basis of the System now in process of construction by the City of Boston. This is believed to have been the first publication in which the application of the Telegraph, not only to the purpose of simple signalizing, but also to that of giving public alarm in case of fire, was announced. Nearly ten years previous to this date, Professor Joseph Henry had devised an experiment, which, however, was not published until within the last two years, in which a distant bell could be struck by means of the release of a heavy weight suspended from his large electro-magnet,—the circuit of which, connected with a local battery, was opened by a small intensity receiving magnet operated by a long or Telegraphic circuit.

The Telegraphic Alarm System, subsequent to 1845, became the subject of occasional publication and its adoption was at length recommended by Hon. Josiah Quincy, Jr., Mayor of the City of Boston, in his official address of January, 1848. At this time Mr. Moses G. Farmer, Telegraphic Engineer, of Boston, directed his attention to the subject, and contrived his very beautiful secondary striking apparatus which will be hereafter described. Two models of this instrument were constructed for the City of Boston and were found to strike a large bell, with which they were connected, with certainty and precision. Sufficient confidence however, was not then felt in the Electric Telegraph, and the experiments were prosecuted no further by the City. In March of the present year (1851) I submitted to the City Government of Boston a detailed plan of the Telegraphic System of Fire Alarms, adapted to the conditions, geographical and otherwise, of the City, and accompanied with estimates of the expense of construction. In June, this plan was adopted, and an appropriation of $10,000 was made to carry it into effect. Mr. M. G. Farmer was appointed superintendent, and has contributed largely from his own resources to all subsequent adaptations and details of arrangement. The System now approaching completion in Boston, with the results of experience in its construction, will be described and illustrated in the course of the following pages.

During the present year the towers or belfries, seven in number, containing the fire bells of the City of New York, have been connected by a Telegraph wire, so that an alarm which had become known to the watchman in one, might be signalized to all the others. The indicating instruments used at these stations are of the most simple description, consisting of a small electro-magnet, armature and bell, with a local battery operated by a receiving magnet on the Telegraphic circuit. Accounts have also been received of the construction of a Fire Telegraph in Berlin by M. Siemens, Lieutenant of Engineers, but whether confined as in New York to simple signalizing, or connected also with automatic apparatus for public alarm, does not appear. The same Telegraph wire is described as connecting electrically the public clocks, or rather dials of Berlin, by a similar application of the electro-magnet, apparently to that made in this country three years ago by Mr. Farmer, to which reference will be made in another connection.

The Electric Telegraph in its common use, or as commonly regarded, is an agency for the transmission of intelligence or impressions to a distance. In this its functions are analogous to the sensitive nerves of the animal system. The Electric Telegraph, especially in its Municipal uses, may superadd to this the production of important mechanical effects, either by its own electro-magnetic energy, or by calling into action other machinery.

The analogy here with the functions of the motor nerves and apparatus of the animal system is equally strict and important. In any system of Municipal organization in which it is attempted to supply a living bond by means of the Telegraph, the distinction between these functions must be recognized; and in any system in which it is desired to employ both of these, to obtain unity of action from a variety of parts, it is necessary that the analogy furnished by the animal system, should be preserved in the relation of these functions. In other words there should be a Centre to which all impressions from the circumference or extremes should first be conveyed over one set of conductors, and from which after an act of intelligence, the impulses to corresponding action should proceed over another. Here is the brain and nervous system of the animal or of man. The Telegraph when employed for any office of social organization of a high order must conform to the same analogy.

As a first condition of the Fire Alarm Telegraph, we have therefore an Electric Centre, where the batteries and certain instruments, with a single operator, are placed,—and two classes of circuits or conductors, one of them *afferent*, *sensitive*, or "Signal," by which the intelligence of a fire is communicated to the Centre, the other, *efferent*, *motor*, or "Alarm," by which the impulse is sent out to the machinery by which the alarm-bells are struck.

The arrangement and security of the Conductors is a subject of primary importance in all applications of the Municipal Telegraph. As a first remark then, experience shows that a simple Telegraph wire, stretched across a City over the house tops, is more certain and reliable as a means of communication in the variable conditions of weather, season, and crowded thoroughfares, than any system of intercourse depending upon sight, sound, or transportation. To illustrate this, the wires of the House Telegraph, extending over a mile through the City of Boston, were interrupted only twice in the course of a year and a half, having been broken both times by snow falling from the eaves of houses, beneath which they had been improperly placed. The Bain wires during the same period, had been broken only once, and then by workmen engaged in building a house with which they interfered. When it is considered that the wires are an open channel of communication by night as well as by day, it will be conceded that no such immunity from accident can be found in any other system, at all commensurable in its functions with the Telegraph. There are however many important safeguards in the erection and arrangement of Conductors in the City, by which the security from interruption of Electric Circuits may be rendered almost absolute, and these will now be considered.

The Conductors commonly used consist of iron wire, supported by insulators upon the houses. These wires, where erected with a view to permanence and stability, should be of the best Swedish iron, and be limited in size and strength only by the strength of the supports which it is practicable to employ. The largest iron wire in common use within our cities is No. 9, which weighs about 325 lbs. to the mile. The construction of the Alarm System in Boston, was commenced with wire No. 8, weighing about 400 lbs. to the mile. It was found however that the brickwork would not often hold the insulators, with the weight of so heavy a wire, without the intervention of brackets of unusual strength, into which the insulators were screwed. In the South Boston Circuit, wire No. 10, weighing rather less than 300 lbs. to the mile, was employed, as giving on the whole greater security, without exceeding very much, by the mode of support, the usual cost of such works. The length of the wire in the Municipal Telegraph of Boston is about 49 miles, and it has probably been erected with greater care and thoroughness than any similar structure in the country.

In a System, however, of such public importance, and designed to be permanent in its character, no effort should be spared to give a massive strength to every part, and ample provision should be made for the careful and judicious survey of routes and selection of the places of attachment for the wires. It is also to be considered that a structure liable to frequent derangement, would be a source of just annoyance to real estate holders in the City, whose buildings are needed for the support of insulators. For these reasons, Mr. Farmer would recommend the appropriation of $150 per mile for the conductors of the Municipal Telegraph, so as to allow the use of large and often elevated brackets, supporting No. 8 wire in carefully selected positions. This is a more elaborate method of construction than has yet been attempted. The wire of the same size, erected in Boston, has cost about $73 per mile, and should possess great strength and stability after it has been tested by exposure, and any weak parts have been replaced.

In the selection of buildings for the support of the Conductors, public edifices, such as churches, school houses, &c., should be preferred, and next to these, lofty and isolated buildings, in order to remove the wires, as much as possible, from danger of interference. Two wires, or, at least, related wires, should not be attached to the same building or block of buildings. The Conductors should be so much elevated above the roofs of houses, that their insulation should never be impaired by contact with fallen snow.

The stretches of wire, in the Municipal Telegraph, should be as long and few as practicable, consistent with security, in order

to avoid loss by imperfect insulation, and the multiplication of places of support, where alone, interference with the wires is possible. In Boston it has not been considered prudent to extend the stretches of the Alarm System generally over two hundred feet, on account of the occasional storms of snow and rain in the winter, in which great accumulations of ice are formed upon the wires. A single stretch however of the House line, of over 800 feet between the towers of neighboring churches, has continued undisturbed for two years. In cities in this country South of Boston, stretches of 300 or 400 feet may be allowable.

From the strength of the conductors they can not be easily interrupted either by accident or design, and in the latter case recourse must almost necessarily be had to instruments. The place of such violence would be apparent, and the broken wire, from its weight and tension, would fall at once to the ground. Detection would therefore be easy. The wires, used for an important public object, would, of course, be protected by law. The police and members of the fire department should be instructed at once to report a broken wire that it may be repaired.

As the interruption of a wire is a possible, though not a probable or frequent occurrence, the principle of Double Conductors must be introduced into any System, in which absolute uniformity of action is required. This is necessary in the chronometric application of the Telegraph, where electric pulsations are sent over the wires every second to measure and mark uniform time on a hundred dials. It is equally necessary in the application of the Telegraph to purposes of public alarm where reliance is placed on the unerring certainty of its operation in a sudden emergency. Hence, between each station of the Fire Alarm System, there are two conducting wires following different routes. A proportionate increase of conducting power is an incidental advantage of this use of two-fold wires.

By a strict regard to the principles of construction and arrangement, which have thus been considered, *the interruption of the circuits of the Municipal Telegraph becomes practically impossible.*

The ground can not be used as any part of the circuit of the Municipal Telegraph without introducing a source of irregularity. A connection, accidentally or intentionally made between the wire and the ground, in such case, would complete an "open" circuit, or throw part of a "closed" circuit out of use. A duplicate conductor would also cease to be an advantage or security, where the circuit would be permanently completed by the interruption and falling of a single wire to the ground. In the Fire Alarm System, the circuits are composed exclusively of wires, and these, in the process of erection, are separated as widely as possible, especially in the case of corresponding wires, whose

cross-connection would complete a circuit. Between the different Stations the wires diverge widely, and at Stations where they may come together for the purposes of signalizing, they are carefully protected. Hence *false alarms*, by an abuse of the wires, are rendered nearly impossible.

Another important result from the exclusive use of wires is *double insulation*. If the ground were used there would be only one insulator between it and the wire above, forming part of the same circuit, but, with wire conductors alone, there are two insulators, besides the buildings and intervening ground, which the current must traverse to make the circuit complete between corresponding conductors. Another useful result of the same arrangement is that the ground is left as a reserve, and can be used temporarily with a separate battery for special police communications, in connection with, or addition to, both of the Signal wires.

As the insulator forms an important part of every Telegraphic System, the form used in the construction at Boston, which is Batchelder's patent, is shown in fig. 1. The cast iron cap is represented by the black line in the section. This is lined throughout with glass, by the operation of blowing, or with porcelain. The shank is then introduced with a hot mass of glass, or any fused or semi-fused material, by which it is firmly fixed in its place. This is represented by the shaded portion. Between the lower edge of the cap and the shank, in the section, there are four inches of glass surface. The reëntering angle of the lower part of the cap protects the glass within from missiles, and is calculated in a storm of wind and rain to drive the latter downward, and thus preserve the insulation. The wires pass over the top of the insulator. The shank, which should be longer than is represented, screws into a bracket or the ridgepole of a house.

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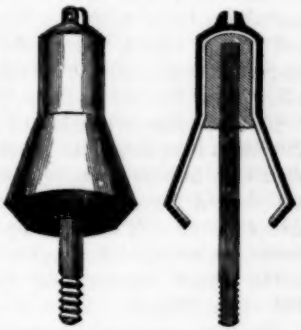


From the difficulty of always obtaining suitable places of support in cities for the conductors carried through the air, the use of insulated wires, buried in metallic tubes, may be resorted to sometimes with advantage, in the Municipal Telegraph. By sinking the tubes beneath the reach of accident or frost, great security may be obtained, but with a great increase of expense. Thus the cost of insulated conductors, laid underneath the streets of cities, may be estimated at from $600 to $1,000 per mile.

To ensure regularity of action as well as for purposes of safety, Dischargers of atmospheric electricity have been provided at every

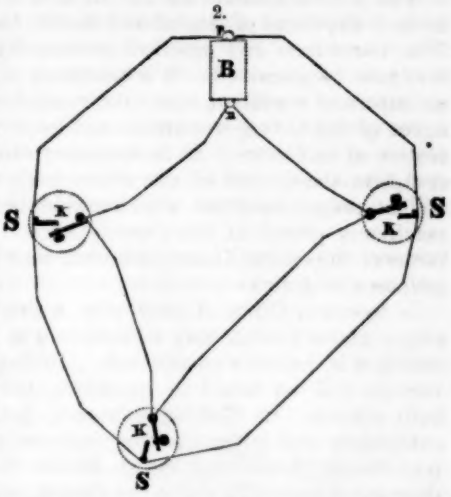
Signal and Alarm Station of the System in Boston, numbering sixty in all. These were constructed by Mr. Farmer, on the principle of conducting to the earth all free electricity, or electricity above a certain degree of tension, and will be figured hereafter. So large a number of these, employed in connection with the circuits of forty-nine miles of wire, above the buildings, can not fail to exert an important influence in silently discharging accumulations of atmospheric electricity. A general protection against danger from this source may thus be incidentally afforded by the Municipal Telegraph.

In a perfect system of Fire Alarms it is necessary that communication should be *instantaneous*, *universal* and *definite*. The Electric Telegraph, by its peculiar properties, affords the means of fulfilling all of these conditions. Its pulsations are transmitted in an inappreciable time over the wires of the Municipal circuit. By the multiplication of Stations in the course of the Signal wires, by which all parts of the City are brought into communication with the Centre, and by the electro-mechanical connection of the various alarm bells with the Centre, the means both of signalizing and public alarm, are made universal. By the use of electro-magnetic machinery, by which District Signals may be struck or tolled upon the alarm bells, at will, the System becomes definite.

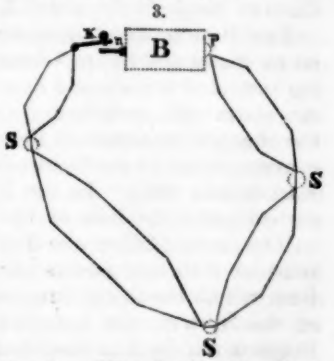
In the communication of a definite alarm, the division of a City into Fire Districts becomes necessary. These will vary in each City according to its size and other conditions. The number should be sufficient to localize a fire without unnecessary complication. The following are the District Divisions which have been adopted in Boston: I, North,—II, West,—III, Centre,—IV, South Centre,—V, South End,—VI, South Boston,—VII, East Boston.

The fundamental division of Circuits into those of Signal and Alarm has already been stated; the one conveying the intelligence of a fire from the Signal Stations to the Central Office,—the other, communicating the impulse to mechanical action from the Central Office to the bells. As the completion or interruption of the Circuit is the condition by which the effects of the battery are obtained in the Telegraph, the Signal Circuit is so arranged that it can be completed or interrupted by means of a Signal Key or Signal Crank at any of the Stations, which are distributed at suitable intervals throughout the City. In fig. 2, the arrangement of the Signal wires with an open circuit is shown. B represents the battery, p and n its positive and negative poles. It will be seen that a conductor starts from each pole, and following the course of the circuit, returns to its point of departure. S, S, S are three Signal Stations. The battery circuit may be completed by the depression of either of the keys K, K, K, or of one of any number of keys similarly situated between the wires. It will be

observed that either or both of the wires may be broken in a single place, and yet every Signal Station will be in communication with both poles of the battery, following the conductors round in one or the other direction. By this arrangement, therefore, the principle of double conductors is preserved. As an additional safeguard, the interruption of either of the wires in a single place would be known at the Central office within an hour, by means of testing apparatus. The wires will be seen to diverge between the Stations, taking routes widely separated. At the Signal Stations themselves where the wires approach, there is the possibility of a cross connection, if the open circuit is used. The building selected for this purpose should therefore be isolated or have a roof as little accessible as possible. This difficulty is obviated by the use of the closed circuit. In this case, depressing the Signal key would break instead of completing the circuit, and the wires would be arranged between the Stations like the links of a chain, as in fig. 3. Owing to the difficulty of keeping the wires sufficiently separated in all parts of the System in Boston, and the occasional use of posts, as in crossing the South Boston bridge, the closed circuit will be partially if not altogether used with the Signal wires.



The Alarm Circuit is so arranged that it may be completed by depressing a key at the Central Office. In fig. 3, B represents the battery at the Central Office, and K the Alarm Key. S, S, S, are Alarm Stations, such as churches, where the machinery is placed by which the bell is struck when the Circuit is completed. Several of these may be included in the same Circuit. The double Conduct-



ors are seen diverging between the Stations, at which they unite in a single wire.

The general grounds for the division of the Circuits, according to their functions of Signal and Alarm, have already been stated. The immediate and practical reasons for such an arrangement will now be perceived. It is necessary, in the first place, to have so important a system under the control of some department or agent of the City government, and to provide for intelligent direction at its Centre. It is necessary also to provide means to complete the Circuit of the alarm bells with perfect regularity and at proper intervals, which would be impossible, except by machinery placed at the Central Office. It is also important to preserve the Signal Circuit distinct, that it may be available for purposes of police.

In towns or Cities of small size, a single Signal Circuit and a single Alarm Circuit may be sufficient to include all the Stations which it is desirable to establish. In larger cities however, advantage will be found in increasing the number of Circuits of both classes. In Boston, economy, both as regards length of conductors and battery power, induced the division of the City into North, South and South Boston Circuits. These arrange themselves naturally about the Centre, and each division has its separate and independent Signal and Alarm Systems. At the Central Office the Circuits of a similar class may all be connected into one, or, which is preferable, they may be kept entirely distinct. An additional security is thus obtained against interruption of the system. If by an improbable chance a single Signal or Alarm Circuit should be interrupted, the integrity of all the others would be preserved, and they would still be available for the performance of their usual functions. The North, South and South Boston Signal Circuits are respectively about $3\frac{1}{4}$, $4\frac{3}{4}$ and 6 miles in length, and the North, South and South Boston Alarm Circuits, respectively, about 3, $3\frac{1}{2}$ and 4 miles.

East Boston, which constitutes the Seventh District, is situated on an island and has no circuit of its own, though a pipe enclosing insulated wires could at any time be sunk under the channel. An alarm will therefore for the present, be signalized across the channel by sound in the usual manner, and will thence be communicated to the Centre by a special Signal Station near the East Boston ferry. In the South Boston Circuit the wires are carried under the draw of the bridge, enclosed in a pipe.

The Central Office, the Signal Stations and the Alarm bell Stations have all instruments peculiar to themselves. As the point from which the initial impulse proceeds in the actual operation of the System, the instruments and connections of the Signal Stations will be first described.

The Signal instruments are contained in a strong cast iron case, and connection is made between this and the Conductors on the top of the building by a wrought iron pipe enclosing insulated wires. Entire protection to the instruments and wires is thus obtained. The Committee of Construction in Boston have wisely decided to place these boxes on the outside of buildings, in places well selected, generally opposite a lamp. These Stations are distributed throughout the City at distances not greater than a hundred rods from each other, so that no house shall be distant more than fifty rods from one of them. Thus there are 18 Signal Stations in the North Circuit, 16 in the South, and 7 in the South Boston Circuit.

The Signal Box, belonging to the Boston System is represented in fig. 4. The box and door consist each of a heavy casting.

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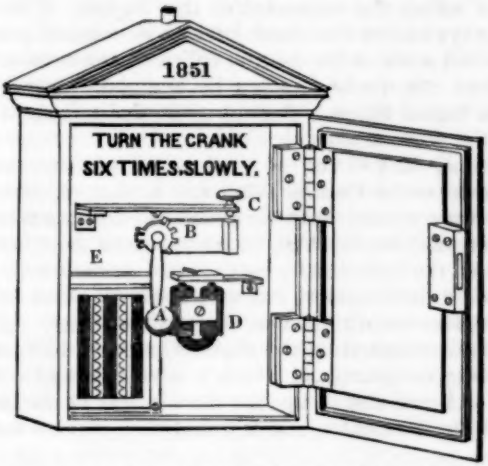

The hinges and lock are of the most substantial kind. The outside of the door has upon it the words Signal Station, with the number of the Station, and a panel containing a notice of the place where the key is to be found, and perhaps also an extract from a City Ordinance for the regulation and protection of the System. The Signal Crank with a heavily weighted handle is seen within the box at A. It was devised by Mr. Farmer and myself, to obviate the irregularity which might arise from the manipulation of the Signal Key by ignorant or incompetent persons. The axis of the crank carries a circuit wheel B provided with a number of teeth or cams, each of which, in revolving, completes the circuit momentarily by a sliding contact with the key C. These cams are divided into two groups, seen in the figure, one on each side of the circuit wheel, the principal of which

groups numbers from one to seven cams, according to the number of the District in which the Signal box is placed. This communicates the District number to the Central Office. The other group consists of from two to four cams, placed closely together, and so formed as to complete the circuit for longer or shorter periods and produce a record at the Central Office, of dots and lines, indicating the number of the Station. The box contains instructions to turn the crank six times. The effect of this, with the Crank represented in the figure, would be to communicate the Signal of the Fourth District, alternating with that of the fifth Station, (a dot, a line and a dot,) six times in rapid succession, to the Central Office, where it would be indicated and registered by proper machinery. The object of the repetition of the Signal is to draw attention and ensure its correct reception. A different number of revolutions of the Crank or its rapid rotation would not affect the character of the Signal. The weighted handle always carries the Crank back to its original position.

The record made at the Central Office by the revolution of the Signal Crank can not be imitated by any person not having access to the Signal Boxes. A great additional safeguard from any abuse of the wires is thus obtained.

The Signal Key C can be used in the ordinary manner, to communicate to the Central Office any system of Signals which may have been agreed upon for police or other purposes. Communications may be received, in return, from the Central Office, by means of the little electro-magnet and armature D, which is introduced in the course of one of the Signal wires. The click of the armature constitutes here the audible signal. This would also be heard on operating the Signal Crank or Key, if the circuit was duly completed, of which it would thus give indication. It would be heard also if another Station was in the act of communicating to the Centre, and it would thus prevent confusion in signalizing.

The Discharger of atmospheric electricity is represented at E. It consists of three strips of brass, resting on varnished wood and covered with a glass plate, with strips of India rubber cloth interposed. The central strip communicates with the ground and has serrated edges which are presented in close proximity to the strips on each side. These strips communicate each with one of the Signal wires. Any free electricity or any intense charge of induced electricity in the wires would thus be discharged, by means of the sharp edges, offered by the ground conductor.

Where the closed circuit is used, the instruments in the Signal Box would undergo a very slight change. The Signal Key would complete the circuit by contact, when at rest, and would break it when depressed by the cams. The electro-magnet D would be included constantly in the circuit, and the click

of the armature would be heard on its release, when the Circuit was broken.

The instruments in the Signal Box are attached to a false back of wood, behind which the communicating wires are disposed. The socket for the reception of the wrought iron pipe containing the insulated conductors, is seen on the top of the box.

Each Signal Station is in charge of a person or family in the immediate neighborhood, whose duty it is to open the Box in case of an alarm and turn the Crank. This act is so simple that it might be performed by a child. Certain members of the Fire, Watch and Police Departments, are also provided with keys to the Signal Boxes. The object to be secured in this arrangement, is abundant access to the Signal Apparatus in case of fire, and yet a sufficient guarantee against its abuse. A periodical report should be required from the agents in charge of the Stations.

Connection may at any time be made between the ground conductor of the electrical Discharger and one of the Signal wires, for the purpose of special Signalizing to the Central Office, without the indication of the signals at any intermediate Station.

The Centre of the System in Boston is established in the City Building adjoining the City Hall. From its roof which is isolated, the wires, elevated on a bracket, radiate in all directions.

The instruments at the Central Office are in part receiving and in part transmitting, besides the batteries for the whole system, and the testing and registering instruments employed in the regulation of the Circuits.

The receiving apparatus consists of an Office Alarm for each of the three Signal Circuits, and a single electro-magnetic Register, of the Morse construction, with which they communicate in common. The Alarm is represented in fig. 5. It is a simple electro-magnet, with an armature attached to the upright lever which carries the hammer. The bell is of large size. For the purpose of obtaining a powerful blow from the hammer, sufficient to rouse any one sleeping in the Office, it may be operated by a local battery with a receiving magnet interposed between it and the Signal Circuit. The Office Alarm with the local circuit ar-

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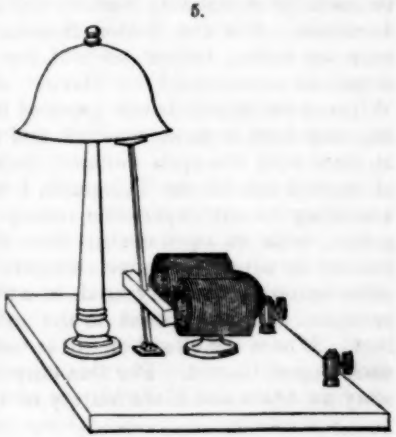

rangement, is an apparatus identical with one figured in Cooke and Wheatstone's English patent of 1837, to which I take pleasure in referring it.

The Register used is the common electro-magnetic register, arranged so as to start and stop itself. It is made to run faster than usual, so as to record legibly the Signals made by the Signal Crank, even when turned rapidly. The Register may be operated by the same local circuit as the three Office Alarms. A Switch is provided to disconnect the Alarm of any Circuit, when the Register is used for continued communication. The Alarms connected with the different Circuits are provided with bells of different tone, so that it is immediately perceived, by the sound, from which circuit any Signal proceeds.

It is often desirable to send a communication back to the Signal Stations for purposes of police, or, it may be, to inform an officer of the Fire Department of the number of the Station from which an Alarm of Fire has been signalized. For these and similar objects, a Key like that which will be described in connection with fig. 8, is placed at the Central Office, in the course of the Signal wire which embraces the little electro-magnets in the Signal boxes; or, if a closed circuit is used, a simple break-circuit Key is introduced in each Signal Circuit. Thus the number of a station signalizing an alarm of fire, or any other Signal, may be counted out, in answer to an enquiry, upon the electro-magnets in all the Signal Boxes of a Circuit, by the Agent or operator at the Central Office.

The Signal Battery may be common to any number of open Signal Circuits, the extremities of each Circuit being connected with its poles as shown in Fig. 2. The same battery may also be used for signalizing back to the Stations in the manner just described. For the Boston System, and with Circuits of not over six miles, twelve pairs of the Odds and Ends battery of Smee, as constructed by Davis,* should be amply sufficient. Where great power is not required from a battery for telegraphing, this form is more constant and manageable than any other, at least with the open circuit. As a fact of general interest in all applications of the Telegraph, I will state that this battery is, according to my experience, many times more enduring in its action, with an open circuit, than the common form of Smee's battery in which the same elements are employed, or than any other battery commonly used, in which the zinc rises above the solution, and is exposed to the influence of the air and water line. Where the closed circuit is used, a battery is necessary for each Signal Circuit. For this purpose a Daniel's battery or possibly an Odds and Ends battery of twelve pairs may be applied.

* Davis's Manual of Magnetism, 2nd edition, p. 56.

The transmitting apparatus, connected with the Alarm Circuit, consists of a common Signal or rather Alarm Key, and of the District Keyboard. The purpose of both these instruments is to complete at suitable times the circuit, by which the machinery at the Alarm Stations is thrown into action.

To obviate the difficulty of completing the circuit by the Alarm Key, with the absolute regularity necessary to strike the District Signals upon the bells, the District Key-board is introduced. This instrument, which in its simple form was early employed in the Telegraph, is represented in fig. 6. The Keys, with

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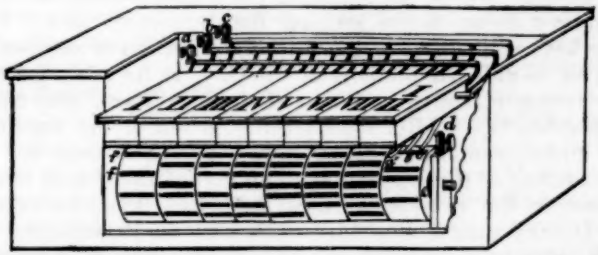

one exception, are seen marked with the numbers of the Districts. Below the Key-board is a cylinder, which is moved by clock-work at a given rate when the instrument is in operation. The cylinder is of wood having a metallic core, *e*. Strips of metal, *f f*, connected through with the core, are set into the wood of the cylinder, so as to form groups under the several Keys, equal in number to the District Signals, marked upon them. Thus, under the Key of District One, single strips widely separated are seen, under the Key of District Two, two strips, and after a considerable interval, two more, and so on. It is obvious, with this arrangement, that if each key should bring a conductor to bear upon the surface of the cylinder beneath, it would complete electric communication through to the core, at regular intervals corresponding to the District Signals.

For the sake of economy of battery power and the security of distinct circuits, it is desirable to throw the force of the Battery upon the three Alarm Circuits separately and in succession. This is effected by attaching three metallic springs a', b', c', to the under surface of each key. These springs when the key is depressed, bear upon the cylinder in an oblique line, that is, a' in advance of b', and b' in advance of c'. The other extremities of these springs make an ample bend behind the Key-board, to allow freedom of motion to the keys, and are then fastened respectively to the metallic bars *a*, *b*, *c*, the corresponding spring of each key being attached to the same bar. Now on depressing any key,

the strips of the revolving cylinder come in contact with the three springs in succession, and if the Alarm Circuits are each connected at one extremity with the three screw cups *a*, *b*, *c*, and at the other, through the Alarm Battery with the screw cup *d* and core *e*, the current is thrown on to each of these circuits in quick succession, and at intervals corresponding to the number of the District marked upon the key.

The figure is represented with seven District Keys, and an eighth, intended for the Signal "All Out," the use of which will be described hereafter. The number of the keys may be increased at pleasure. A key for fast striking, that is once in about two seconds, will be introduced in the Boston System as a means of general alarm, before striking the District Signals. Three spare keys will also be assigned for the direction of engines, belonging to different sections of the City, or for other purposes. The system of alarm, by means of the Key-board, may also be further developed, after some practice, if not at the time of its first introduction, by providing keys which shall cause not only the number of the District, but also that of the Signal Station, nearest the fire, to be struck upon the bells. Thus for example, the District number would be struck with blows, separated from each other by an interval of two seconds; then a pause would intervene of four seconds; then the number of the Station would be struck with blows having an interval again of two seconds; and finally a pause of eight seconds would follow before the commencement of another Signal. With a key for each Station, in addition to those for other purposes, this would require in Boston a Key-board of forty-eight keys.

The clock-work which carries the cylinder is not shown in the figure, but it can be regulated so as to give any interval which may be desired or may be necessary between the strokes of the alarm bells. The keys are so arranged that the depression of any one liberates the clock-work and sets the cylinder in motion, and the subsequent release of the same key stops the clock-work at the end of one revolution of the cylinder. While the key is held down the electric impulses continue to be sent out at measured intervals over the wires.

It may often be desirable to confine an alarm to only one or two of the Circuits. This is easily effected by a Switch placed upon each Circuit, so as to shut it off at will from connection with the cylinder.

The Battery connected with the District Key-board and Alarm Circuits consists of about twenty-five pairs of Grove's arrangement of large size. Very considerable power is required to produce the necessary electro-magnetic effects at the Alarm Stations, even through circuits not exceeding four and a quarter miles in length. A great economy of battery power is therefore

obtained by the action of the Key-board, which communicates the same Signal in succession to the different Circuits.

In connection with each of the Alarm Circuits, as they pass out of the Central Office, is an Alarm Bell Register for indicating the number of Electric impulses sent over the wires, and the corresponding number of blows struck upon the bells by the hammers of the Striking Machines. In form it is similar to a register in use for other purposes. The movement resembles that of Mr. Farmer's electro-magnetic clock. There are three cylinders, seen partially in the figure, whose circumference is divided decimally and marked with figures, representing in their place, units, tens, and hundreds. The armature of an electro-magnet carries a ratchet, which at every impulse of the current moves the unit cylinder forward one figure, at every tenth impulse moves the cylinder of tens also forward one figure, and at every hundredth impulse moves the cylinder of hundreds forward one figure, in addition to both the others. The indications of this instrument are very important in connection with machines carried by weight. Thus, if alarms are very frequent, the Alarm Bell Register may show that the striking machines require to be wound up in anticipation of their regular time.

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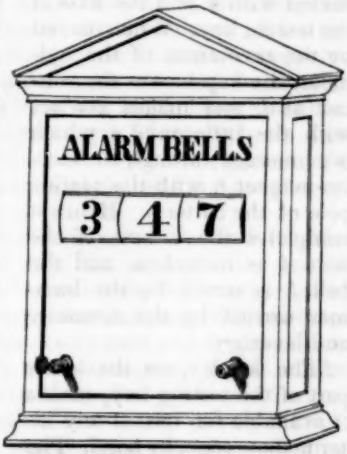

It is essential to have systematic means of testing all the Circuits, employed in the Fire System. Where a closed Signal Circuit is used, an interruption from any cause, gives of itself a Signal at the Central Office. Where an open circuit is used, as it is, in connection with the Alarm machinery, or may be, in connection with the Signal apparatus, other means must be employed. The Testing Clock is shown in fig. 8, (see next page.) It is a common once-striking clock, of which the hammer and bell are removed, and the cylinder *a*, so connected with the striking movement as to make one revolution at the usual time of striking. On this cylinder are pins arranged spirally, equal in number to the number of Circuits which it is desired to test. These pins in the course of their revolution, deflect each a testing key *b*, of which keys, for the sake of clearness, only one, with the corresponding parts is shown in the figure. The upper part of the testing key is made thin and elastic, so as to yield slightly

to the passage of the pin. Its arrangement in the figure shows its application to testing the continuity of one of the Signal wires, represented in fig. 2. In its usual position, the testing key is held by a spring, in contact (which should be a sliding contact,) with the little anvil *d*. It will be seen that the wire *k*, connected with the zinc pole of the battery *i*, makes a perfect circle, returning into itself through the screw-cups connected with *d* and the axis of the testing key. When moved by the revolution of the cylinder, the key breaks the contact at *d*, and makes contact with the little anvil *e*, which is connected through the electro-magnet *f*, with the platina pole of the battery. Hence it completes the circuit, if the wire *k* is unbroken, and the bell *h* is struck by the hammer carried by the armature and lever *g*.

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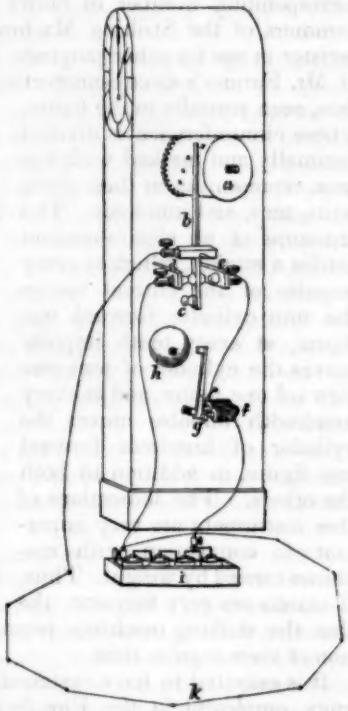


The knob *c*, on the lower part of the testing key, makes it available for use, at any intermediate time, by hand. The arrangement of this key also shows how a single wire of the Signal Battery can be brought into circuit, for the purpose of communicating back to the Stations. It will be observed that one end of the wire *k* always remains connected with its battery, whether the key *b* is manipulated or not. Its function of signalizing fire is therefore never interfered with.

The testing key applied to the Alarm Circuit connects it momentarily with a battery, perhaps the Signal battery, too weak to set off any of the striking machinery, and yet strong enough to actuate the electro-magnetic alarm within the clock. In the Boston System, if the six wires of the Signal Circuits and the three Alarm Circuits should be tested together, nine bells would be struck in regular succession, at the time of the usual striking of the clock. These should be separated from each other in tone by a musical interval, and bells representing different classes of circuits should be in different parts of the scale. If one of

these notes were omitted it would at once be perceived. Taken together, the chime would furnish hourly assurance of the integrity of all the Circuits of the System.

Mr. Farmer has also devised a method of testing, by means of his electro-magnetic clock, affording equal facilities with the mode which has been described. Once each hour the current is thrown, by successive oscillations of the seconds pendulum, upon as many circuits as it is desired to test. This method gives obviously a very wide range, both as to number of circuits and the intervals of time at which the application can be made.

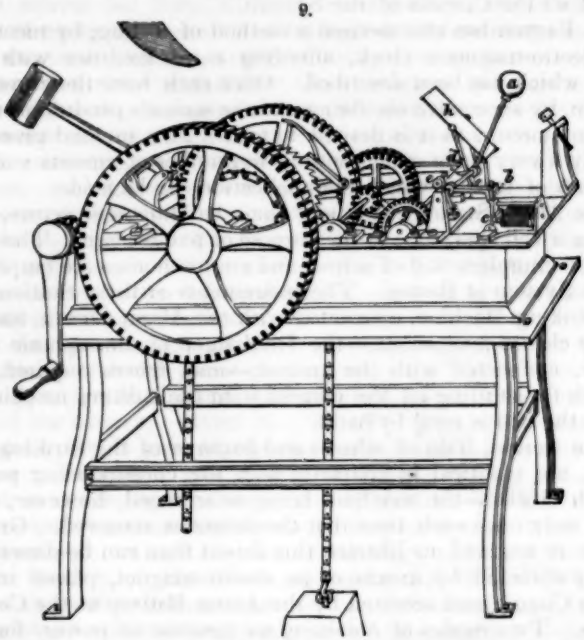
The Alarm Station consists of some building or structure, containing a bell applicable to the purpose of public alarm. Thus the bells of churches, and of school and engine houses are employed in the System at Boston. The instruments at these Stations are the Striking Machine, connected with the Alarm Circuit, and set off by electro-magnetism,—the Discharger of atmospheric electricity, connected with the ground,—and, where required, the Switch for shutting off the current from the striking machinery, when the bell is rung by hand.

The weight, train of wheels and hammer of the Striking Machine, are identical in character with the corresponding part of church clocks,—the machine being so arranged, however, as to strike only once each time that the detent is removed. Greater power is required to liberate this detent than can be directly or readily obtained by means of an electro-magnet, placed in the Alarm Circuit, and actuated by the Alarm Battery at the Central Office. Two modes of obtaining an increase of power, for this purpose, exist; one, by including in the Alarm Circuit a receiving magnet, which brings into action a local battery, operating the electro-magnet by which the detent is liberated. In this case the local battery may consist of three or four pairs of the odds and ends form, which, in an open circuit, need no care for several weeks, if not months, at a time. The other mode is by employing some secondary apparatus, liberated by the electro-magnet in the Alarm Circuit, to raise the detent. This method was applied by Mr. Farmer in 1848, in his very beautiful instrument, which which will now be described.

Fig. 9 (see next page) represents the precise form of the Striking Machines, constructed by Howard & Davis, for the City of Boston. The frame is a most substantial casting. The electro-magnet will readily be recognized, with its armature attached to an upright lever at *c*. The legs of the electro-magnet consist of half-inch soft iron, surrounded with coils of insulated copper wire No. 23, which are three inches long and two inches in diameter. *a* is a falling arm, weighted at the top, which is supported in an upright position by a horizontal lever, resting on the top of the armature lever at *b*. When the armature is attracted to the magnet, the

weighted arm *a* falls over until stopped by the adjustable rest in front of it. In falling, a little lever, seen attached to the

9.



same axis, raises the latch-shaped detent *d*, by means of the pin connected with it. The arm carrying the pin *e*, attached to the same axis with the cam *g*, and connected with the train of wheels of the striking machinery, is thus liberated, and commences to revolve on its axis. In so doing the cam *g* swings forward the bar *f*, attached to the axis of the falling arm *a*, which is thus raised to its original position; the horizontal lever catches again at *b* if the armature has been released, the detent *d* falls, and the pin *e* is arrested at the end of one revolution. This occupies two seconds, and in the meantime the weight of perhaps 2000 lbs. has fallen an inch, and a single blow has been struck by the hammer. If the armature were not released from the attraction of the electro-magnet, the horizontal lever would not catch at *b*, and the machine would continue to strike, until the circuit, influencing the electro-magnet, was interrupted. This indefinite and undesirable mode of striking would be produced by holding down the Alarm Key at the Central Office. To obtain single blows, for the purpose of definite alarm, the circuit must be completed momentarily at suitable intervals, which is best effected by means of the District Key-board. The fly-wheel of the clock work is

shown at *h*. The hammer represented in the figure is usually placed in a belfry above, connected with the hammer lever by a wire.

The bells to which the striking machines are applied in Boston, vary in weight from 3,700 to 300 lbs. The machines are of uniform size, but they are carried by weights, varying from 2000 to 800 lbs., on a single chain. It was supposed in the outset that a blow equal in force to that of the common tolling hammers, would be sufficient for all the purposes of alarm, especially as, in the Telegraphic System, an alarm is not propagated by sound, from bell to bell, as in the ordinary method. A greater amount of sound was however considered desirable by members of the Fire Department, and a great addition to the force of the hammer was found necessary to produce adequate vibration in the largest bells. Thus the hammer, judged suitable for the bell of Brattle St. Church, weighs forty pounds, has a handle three and a half feet long, swings through an arc of four and a half feet, and is moved at each blow by a force equal to a weight of 1440 lbs., falling one inch. To liberate the detent of a machine of this power, the weight on the falling arm must be proportionally increased, and the electro-magnetic power required to free the arm will amount to about 14,000 grains when the armature (faced with brass) is in contact with the electro-magnet. The battery provided at the Central Office must be adequate to produce this effect through the Alarm Circuits.

The striking machines are calculated to strike 1000 blows with a fall of the weight equal to 83·33 feet on a single chain, that is, at the rate of one inch to a blow. Where a great expenditure of power is required, and the weight is applied by a single chain with a limited fall, the number of blows which can be obtained from a single winding is necessarily diminished. Thus the number of blows with the three largest bells in Boston, will not probably exceed 450 or 500. Fortunately these bells are near the Central Office, and can be easily wound up when the Alarm Bell Register, represented in fig. 7, indicates that they are nearly run down.

The striking machines should be wound weekly, and a detailed report made, by the person winding them, to the Central Office, where it should be entered on the journal. All intermediate windings should be entered in a similar manner.

The time required between successive blows of the Striking Machines is two seconds. The revolution of the cylinder in the District Key-board, fig. 6, should be graduated so as to complete the circuit, for consecutive blows, at precisely this interval. The average number of blows, in striking District Signals with intervals of five seconds after each Signal, is about twenty per minute. From fifty to a hundred blows would be sufficient, ordinarily, for a single alarm.

A single Alarm Circuit may include a number of Alarm Stations. In all of these, in which the conditions are similar, the blows upon the bell should be synchronous. No matter how widely scattered over a City, the Signals would be struck on the different bells practically at the same moment of time. Differences however in size, friction, proportion, would always exist, sufficient to make a slight difference in the instant of striking between a number of bells. Even if this were not so, difference in distance would cause the sound of one bell to reach the ear before another. Hence District Signals are always distinguished by listening to the sound of a single bell. The effect of the District Key-board is to strike in succession the bells of different Circuits. The interval in sound, however, thus occasioned, would not be so great as that produced by distance in bells of the same Circuit.

In Boston there are eight Telegraphic Alarm Bells in the North Circuit, nine in the South Circuit and two in the South Boston Circuit. These bells are for the most part the same previously employed for the purpose of alarm. The irregularity of surface in the City indicated the use of a number of bells, instead of the employment of a few large ones as in New York. The resistance to the battery current in the South Circuit, 3½ miles in length and including nine Alarm Stations, is greater than in either of the others. The coils on the electro-magnet of each striking machine offer a resistance equal to a mile of single No. 8 wire, or to half a mile of double wire. The nine Stations would be equal therefore in resistance to 4½ miles of Circuit, which gives a total resistance of eight miles of double No. 8 wire, through which the Battery must act.

The Dischargers of atmospheric electricity at the Alarm Stations are similar in principle to those already described, and need not be farther considered. Where the bells are rung for other purposes, it is necessary that there should be a lever within reach of the bell ringer, communicating with a Switch above, for the purpose of turning the current off from the coils of the Striking Machine through a short circuit, during the period of ringing the bell. Otherwise the bell or hammer would be liable to injury in case the actions of ringing and striking should proceed at the same time. A little electro-magnetic alarm may also be provided to notify the bell ringer of the commencement of an alarm of fire, to which it would be his duty to give precedence. A Switch, which should be automatic, or dependent simply on the commencement and cessation of the motions of ringing, would on many accounts be desirable.

The operation of the System has been shown in its detached parts. It will now be illustrated consecutively through all its stages. A fire having broken out in the neighborhood of the

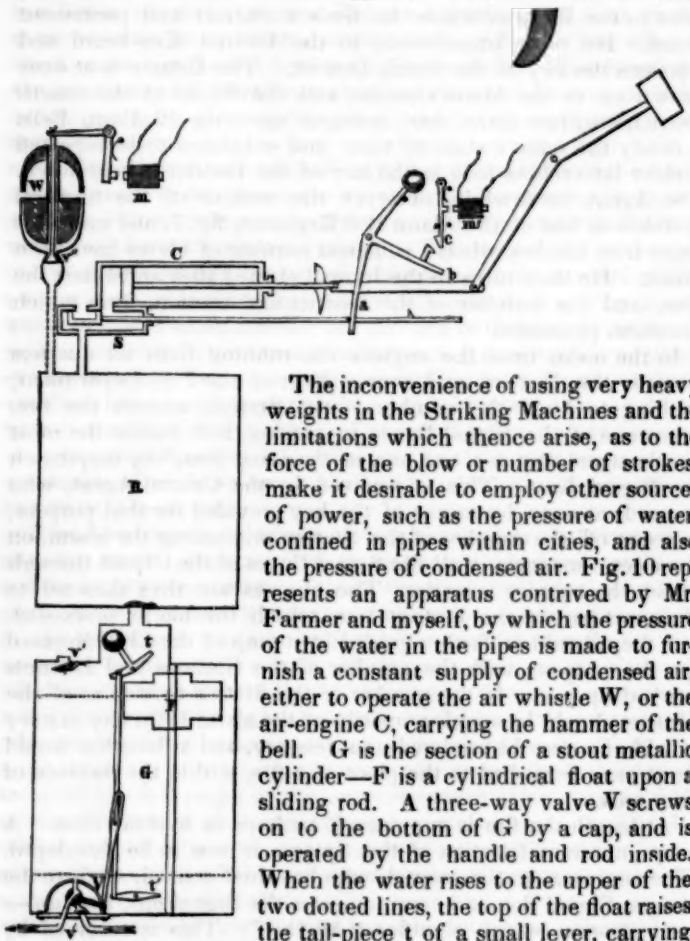
fifth Signal Station in the Fourth District, of which the Box is represented in fig. 4, the person in charge of this Station, or, at night, a watchman, opens the Signal Box and turns the Crank six times. The Alarm at the Central Office is struck every time that the circuit is closed, and the Register records, at the same moment, the District Signal of four consecutive marks, six times repeated, alternating with the Telegraphic Signal, a dot, a line and a dot, indicating the number of the fifth Station. The Agent at the Central Office, if aroused at night by the Alarm, refers to the Register where he finds a distinct and permanent record. He turns immediately to the District Key-board and depresses the key of the fourth District. The Battery is at once thrown on to the Alarm Circuits, and the Signal of the fourth District, *one, two, three, four,* is struck upon the 19 Alarm Bells at nearly the same instant of time, and continues to be repeated at short intervals as long as the key of the District is held down. The Agent, meanwhile, observes the motion of the numeral cylinders in one of the Alarm Bell Registers, fig. 7, and raises his finger from the key when a sufficient number of blows have been struck. He then turns to the Journal of the Office and enters the time, and the number of the District and Station, from which the alarm proceeded.

In the mean time the engines are running from all quarters towards the District, and some officer of the Fire Department, wishing to know the number of the Station, nearest the fire, opens one of the Signal Boxes in passing, and makes the most simple signal, say *one, one, one,* or "writing dots," by tapping on the Signal Key. This is received by the Central Agent, who proceeds at once, by means of the key provided for that purpose, to count off the number of the Station originating the alarm, on the electro-magnets in all the Signal Boxes of the Circuit through which the enquiry is made. The engines are thus directed to the exact part of the District from which the alarm proceeded, and they should be farther guided by a map of the City, prepared for the purpose, with the number of the Stations and Districts marked upon it. If the number of the Station as well as of the District should be struck primarily on the alarm bells, any inquiry would of course be rendered unnecesssary, and a direction would be at once furnished to the place of a fire, within the distance of fifty rods.

At length the fire is suppressed, perhaps in a short time. A very important function of the System is now to be developed. The engineer, on the ground, who has chief control, sends to the nearest Signal Box and communicates the Signal *one, one-two,— one, one-two,* which signifies "All Out." This is received by the Agent at the Central Office, who immediately depresses the key of the District Key-board, marked in fig. 6 with the charac-

ters I, II. This Signal is forthwith struck and repeated a few times on all the bells. The engines in various and perhaps distant parts of the city turn back. A different signal might be employed to order back the South Boston or North End engines, and two spare keys, having connection with only a single circuit, may be added to the Key-board for this purpose; or the Agent may send such a signal over any Alarm Circuit by means of the Alarm Key.

10.



The inconvenience of using very heavy weights in the Striking Machines and the limitations which thence arise, as to the force of the blow or number of strokes, make it desirable to employ other sources of power, such as the pressure of water, confined in pipes within cities, and also the pressure of condensed air. Fig. 10 represents an apparatus contrived by Mr. Farmer and myself, by which the pressure of the water in the pipes is made to furnish a constant supply of condensed air, either to operate the air whistle W, or the air-engine C, carrying the hammer of the bell. G is the section of a stout metallic cylinder—F is a cylindrical float upon a sliding rod. A three-way valve V screws on to the bottom of G by a cap, and is operated by the handle and rod inside. When the water rises to the upper of the two dotted lines, the top of the float raises the tail-piece t of a small lever, carrying an upright arm, with a heavy ball on the top. This ball passes beyond the perpendicular and falls over on the other side, as seen

in the figure, reversing at the same moment the three-way valve by a simple arrangement. The water which before entered now begins to flow out. The valve v′ opens and admits air. The float falls until at last it rests on the tail piece t′ of a corresponding short lever below, by which the heavy ball is raised to the perpendicular and thrown over on the other side, reversing the three-way valve again, so that the water enters. The water, on entering each time, condenses the air into the reservoir R, from which a valve prevents any return. This process continues till the air in R has reached a condensation equal to the pressure of the column of water in the pipes. Any loss of pressure from either leakage or use is at once supplied by the action of the generator G. All the parts in the generator liable to oxydation, are made of brass.

The reservoir R may easily contain several hundred charges for the cylinder C, so that if the water should be withdrawn from the pipes for a day or more, no interruption in the means of alarm would take place. With a pressure of two or three atmospheres, such as can be obtained from the Cochituate water in the lower part of Boston, a cylinder, C, of only two or three inches diameter, applied directly to a hammer as above, would give all the power which could be desired for the largest bell, without any limit as to the number of strokes, or necessity of winding. The electro-magnet m′, armature and catch c, on which the corresponding part of the falling arm rests, when raised from the position in the figure, will be easily recognized. When the armature is attracted to the magnet the falling arm drops, and the foot, a, catches a pin on the sliding valve and throws it back, admitting the air into the cylinder. The cam and projection on the end of the piston rod, respectively reverse the sliding valve, and raise the long arm b of the falling lever, at the end of the stroke. In the apparatus represented, the generator G must, of course, be placed in a low situation, such as a cellar, and out of the reach of frost.

The air whistle, operated by hand, was proposed a year ago in Boston as a means of alarm. Its efficiency for this purpose can hardly be overrated. The simple mode of connecting it with the Telegraph, represented in the figure, has been proposed by Mr. Farmer. The air valve v″ is operated by a rod, attached to the armature lever of the electro-magnet m, which is actuated by a local battery connected with the Telegraphic circuit. The same object may be accomplished, without a local battery, by a little falling lever and air engine apparatus. Two or three air whistles of large size in a City, would be almost sufficient of themselves for a System of Alarm.

The use of the water meter of Mr. Huse, as a source of power for striking the bells, has suggested itself, and has also been especially brought to my notice by Mr. Joseph M. Wightman of Boston.

This very useful and ingenious instrument can be best described as the converse of a rotary pump. I have satisfied myself that the falling arm liberated by the electro-magnet, could be made to open the water-valve, and that a meter supplied by an inch or inch and a half pipe, would furnish ample power to lift the hammer required for any of the City bells. For this purpose an arm may be placed across the axis of a meter, each end of which, in revolving, would raise the lever connected with the hammer handle above. The hammer would thus be raised at every half revolution of the meter. As the pressure of the water is liable to vary, or as it may be completely withdrawn, an intermediate reservoir of water under the pressure of air, condensed by the previous entrance of water from the pipes, the return of which is prevented by a valve, would seem to be necessary. This is the chief objection to its use. Greater electro-magnetic power would be required to work a water-valve, than the air-valve represented in the last figure.

The principal instruments employed in the Fire Alarm System are included under no existing patent, although Mr. Farmer reserves to himself the right to those parts of the mechanism which he has originated. The electro-magnetic Register, patented by Professor Morse, constitutes, however, an exception. It is desirable to use this instrument for the record at the Central Office, as its principle is in harmony with the rest of the System. On this account, and also to set at rest any other claim under the patent of the electro-magnetic Telegraph, I should recommend, in all cases of construction the purchase of the right to the use of the Morse instruments in connection with the System. This has accordingly been done by the City of Boston.

The following table furnishes an approximation to the cost of different parts of the System, erected in Boston, which is of interest in connection with future constructions.

Average cost per mile of 49 miles wire, (erected) .	$68 72
" " of wire No. 8, per mile, ...	73 00
" " " " No. 10, " "	62 50
Striking machine, fig. 9, (including 800 lbs. weight,)	165 00
Signal Box, apparatus and connections, complete, .	10 00
District Key-board, fig. 6, (with 12 keys), . .	75 00
Alarm Bell Register, fig. 7, ...	10 00
Office Alarm, fig. 5, ...	8 00

The estimate, furnished by me to the City Government of Boston, of the cost of construction of the System, was about $8000, not including superintendence or the right to the use of the Morse instruments. It is believed that this estimate has not been exceeded by the actual cost of the parts included in it. An addition has been made to the number of Signal Stations and to the

length of the Signal wires, and also to the proposed power of the Striking Machines, by which the total expense will be increased perhaps more than a thousand dollars. The cost of superintendence and of the patent right will probably amount to nearly two thousand dollars.

The System can be introduced into small towns where two or three bells and a few Signal Stations are to be connected with the wires, at a cost, for the mechanical part, not exceeding one thousand or fifteen hundred dollars,—and into larger towns or cities at a proportionate rate. In the smaller towns the same wires may be used for both Circuits, that is, to constitute a closed Signal Circuit with a feeble battery, and subsequently an Alarm Circuit, by switching on, at the Central Office, a powerful Alarm Battery. This would diminish the cost of the Circuits nearly one half, but the principle of double conductors, in this case, should still be preserved.

In the approach of the System to its completion in Boston, no doubt exists as to its mechanical efficiency, and to the precision of its operation, except where departures, almost unavoidable in a first experience, may have been made from the principles of construction, already indicated. The introduction of the System may be influenced by moral causes, but these have not been found, heretofore, to embarrass the working of the Telegraph in this country. Here is simply a test of the civilization of our people. Local and peculiar obstacles may also affect the System in its introduction. It is believed that none of these difficulties will prove insurmountable in the trial about to be made in Boston, but that with patience and experience the uses of the System will be fully developed. Should it be otherwise, the System is still correct in principle, and will wait its own time for general adoption.

Great credit is due to the government of the City of Boston for the liberality with which it has tried this experiment. To the Superintendent, Mr. Farmer, intelligently seconded by the Committee of construction, the praise of great practical efficiency and skill should also be awarded.

The application of the Telegraph to Fire Alarms is a step in Municipal organization which has become necessary and must lead to others of a higher order. The beautiful chronometric application of the Telegraph, by which a single clock registers its time on an indefinite number of dials throughout a city, by the simple magic of the electric circuit, is also one which deserves to be brought into immediate public use.

Boston, Nov. 11, 1851.

ART. X.—*Observations on the Freezing of Vegetables, and on the Causes which enable some Plants to endure the action of extreme Cold;* by JOHN LE CONTE, M.D., Professor of Natural Philosophy and Chemistry in the University of Georgia.*

IN the years 1775 and 1777, John Hunter communicated to the Royal Society two series of experiments on the "Heat of Animals and Vegetables," from which he drew the inference, "that an animal must be deprived of life before it can be frozen," and "that plants when in a state of actual vegetation, or even in such a state as to be capable of vegetating under certain circumstances, *must be deprived of their principle of vegetation before they can be frozen.*"† Again he says, "But the question is, is every tree dead that is frozen? I can only say, that in all the experiments I ever made upon trees and shrubs, whether in the growing or active state, or in the passive, that whole or part which was frozen, was dead when thawed."‡

With respect to animals, Hunter concluded from his experiments, that when the whole was frozen the actions of life could *never* be restored; but that the ears of rabbits and the combs of cocks were frozen without injury to the parts.§ More recent observations have convinced animal physiologists that Hunter's generalization was premature; and that a degree of cold which absolutely freezes their bodies is not equally fatal to all classes of animals. The warm-blooded vertebrata are destroyed by it; and many insects in their perfect state are said to suffer in like manner. On the other hand, many fishes, and some reptiles, may be completely frozen without their vitality being necessarily lost. Sir John Franklin, Pallas, Bell, and many others relate, that certain species of fish, which are found imbedded in the ice of the polar regions, are restored to life when thawed. Hearne in his journey from Hudson's Bay to the Northern Ocean, mentions his having found various species of frogs so completely frozen that their legs were as brittle as pipe-stems, and which resumed their natural movements when exposed to a genial heat. If permitted to freeze again after being thawed, they never recovered. He found spiders and grubs in a like frozen condition, with the same powers of revivification on exposure to a warm atmosphere.‖ The *larvæ* of insects are equally tenacious of vitality. Lister, Bonnet and others, have found caterpillars so frozen that when drop-

* Read before the "Physical Section" of the "American Association for the Advancement of Science" at the Albany meeting, August 19th, 1851.

† Phil. Trans. for 1775, pp. 452 and 454. ‡ Phil. Trans. for 1778, p. 40.

§ Phil. Trans. for 1778, p. 34, et seq.

‖ Vide Hearne's Journey from Prince Wales' Fort, Hudson's Bay to the Northern Ocean, pp. 397 et 398. Lond., 1795.

ped into a glass they chinked like stones; but that they nevertheless revived. The Papilio brassicæ has been produced from a larva which had been exposed to a cold of 0° Fahr., and which had become a lump of ice. Spallanzani found that exposure to a temperature of −38° or even −56° Fahr., did not destroy the fertility of the ova of silk worms; and the eggs of the slug have been subjected to a cold of −40° Fahr. without injury. The following experiment upon caterpillars, tried in Sir John Ross's voyage, seems to be perfectly satisfactory on this point. Thirty larvæ of the Laria Rossii were put in a box, and exposed to the winter temperature for three months; on bringing them into the cabin, every one of them returned to life and crawled about. They were again exposed to an atmosphere of −40° Fahr., and instantly became re-frozen; after a week, they were brought again into the cabin, and twenty-three returned to life. These were again exposed and re-frozen; and, after being solid for another week, *eleven* of them recovered on being brought into the cabin. A fourth time they were frozen, and only *two* survived.*

The foregoing facts appear to indicate, that the power of revivification after the complete congelation of the fluids, is confined to animals in which the function of calorification is imperfectly performed, and in which all the vital processes are obscurely manifested. As all the functions of vitality are still more obscurely performed in plants, we should naturally expect them to be endowed with a similar power of resisting the destructive effects of freezing. Nevertheless, the most eminent writers on vegetable physiology seem to be very general and decided in the opinion, that the complete solidification of the fluids of a plant necessarily and inevitably results in its death. For, although it is well known to practical horticulturists, that the pernicious consequences of severe cold on growing vegetables, may be, to some extent, obviated by careful and gradual thawing; yet, it is thought

* Vide Carpenter's Principles of General and Comparative Physiology. 2nd ed. Lond., 1841. pp. 158, 174 and 175.

The recent observations of Prof. James Paget, seem to show, contrary to the opinion of Hunter, that it is *not* by the power of a vital principle that eggs resist the influence of cold. His experiments prove, "that certain things will destroy the power of resisting cold without affecting the capability of being developed, and of therein manifesting the best evidence of life; and that when eggs yield to the influence of intense cold, they are not damaged unless they are frozen, and are *not killed* even when frozen. The experiments thus remove almost the only remaining support of the hypothesis that such a vital principle may exist in organized bodies, as may enable them, even while inactive and displaying no other signs of life, to resist passively the influence of physical forces." Prof. Paget thinks, that the fact that the temperature of eggs may be reduced far below the freezing point without being frozen, is due, not to any vital principle, but to some peculiarity of the mechanical constitution of the albumen, "by means of which the water combined with it is held so steadily, that the agitation favorable, or even necessary, to the freezing at or near 32° cannot take place," (vide Phil. Trans. for 1850, p. 221, et seq.)

that, in such cases, the freezing is incomplete and does not involve all of the structures of the plant. Thus for example, M. Aug. Pyr. De Candolle, after enumerating the effects produced by a partial freezing of the internal parts of trees, in which the *alburnum* is the only part attacked and disorganized, giving rise to what are called *gelivures*—remarks, "Enfin, si le gel est assez fort dont le liber, *alors la branche ou l'arbre dont le liber gèle périt presque toujours*, soit que la gelée du liber soit un signe de la gelée totale de l'aubier, soit que le rôle du liber soit luimême plus important et lié avec la congélation de tous les bourgeons."*

Again he says, "Si elle (la temperature) descend au-dessous de la congélation, elle solidifié d'abord l'eau située à l'exterieur du végétal, et arrête d'autant la nutrition; puis elle atteint les liquides aqueux renfermés dans le tissu végétal, en les congelant elle les dilate; de cette dilatation résulte *la mort du végétal ou du fragment de la plante où elle a lieu*, soit, comme l'ont cru plusieurs auteurs, par la rupture des cellules et des vaisseaux (fait que les recherches récentes de M. Gœppert rendent au moins très douteux), soit par la dénaturation des sucs euxmêmes que la gelée tend à séparer en parties plus ou moins susceptibles de congelation, soit simplement par un effet vital sur le tissu des cellules."† Prof. J. S. Henslow remarks that, "when the sap is frozen, the cells and vessels in which it is contained are ruptured, *and the parts subjected to such an accident die.*"‡ Again, the same botanist says, that, "whenever the sap does freeze, it produces the effect technically termed "shakes" (probably the *roulure* of the French) in timber trees, which consists in a tendency in the separate layers of wood to disunite."§ References might be multiplied to show how universal this opinion is among the best vegetable physiologists. Although most of them reject the idea of Hunter, that a plant must be deprived of the principle of vegetation *before* it can be frozen; yet they appear to be almost unanimous in the opinion, that *after* complete congelation it necessarily dies. It is true, that several facts which seem to contravene this opinion have not failed to arrest the attention of several botanists. Thus M. De Candolle cites the fact, attested by M. Thouin, that the cases of apple trees sent to Moscow, arrived there in a frozen condition, and that a great part of them were saved by gradual and slow thawing.‖ It appears however that such phenomena have attracted but little attention, and provoked no scientific research; they have remained barren and isolated facts in the field of science.

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* Physiologie Végétale, tome 3, p. 1119. Paris, 1832.

† Op. cit., supra tome 3, p. 1101.

‡ Principles of Descriptive and Physiological Botany, Lardner's Cabinet Cyclopedia, p. 297. London, 1844.

§ Op. cit. supra, p. 173.

‖ Physiologie Végétale, tome 3, p. 1122.

From a careful examination of Hunter's experiments, I am surprised, that either he or his successors should have drawn such conclusions as have been deduced from them in relation to the effects of cold on vegetables. For example, we will cite his second experiment in his earlier paper; "A young Scotch fir, which had two complete shoots and a third growing, and which consequently was in its third year, was put into the cold mixture which was between 15° and 17° Fahr. The last shoot was frozen with great difficulty, which appeared to be owing in some measure to the repulsion between the plants and the water. When thawed, the young shoot was found flaccid. *It was planted;* the first and second we found *retained life*, while the third or growing shoot withered."*

Again, in his second series of experiments, when the temperature of the air was 16° Fahr., he found a thermometer inserted into the trunks of a number of species of trees, to stand at 17° Fahr. Now, he found that the sap taken from the walnut tree on which he made the experiment, would freeze at 32°; and furthermore, that the sap which filled an old hole which he had made in the same tree, became frozen when the temperature of it was 31° Fahr.

Assuming that the juices of the tree were not frozen when their temperature was 17° Fahr., Hunter very naturally inquires, "Now, since the sap of a tree when taken out freezes at 32° Fahr.; also since the sap of the tree when taken out of its proper canals, freezes when the heat of the tree is at 31°; and since the heat of the tree can be as low as 17° Fahr. without freezing; by what power are the juices of the tree, when in their proper canals, kept fluid in such cold? Is it the principle of vegetation?"† Hunter has not informed us in what manner he ascertained that the juices of the tree were not frozen when their temperature was 17° Fahr.; but the presumption is, that he had no other reason for thinking so, than the fact, that the tree *was not killed.* He appears to have been so much prepossessed with the idea that plants "must be deprived of their principle of vegetation before they *can* be frozen," that he never thought of determining, by direct observation, whether or not the sap of the tree was actually frozen when its temperature was 17° Fahr. The very first principles of philosophizing demand, that it should be clearly and undeniably established as *a matter of fact*, that *every case* in which the sap of a plant *is frozen* is invariably followed by the death of the whole plant or at least of the part congealed, before the fact of its having survived, can be made the basis of the conclusion that congelation of the juices had not taken place. The assumption is made that a plant which is not killed by cold,

* Phil. Trans. for 1775, p. 451.

† Phil. Trans. for 1778, pp. 47, 48.

never was frozen, and then theories are framed to account for the presumed fact.

Impressed with this fundamental idea, all attempts which have been made by modern phytologists to explain how vegetables endure the action of excessive cold, resolve themselves into an enumeration of the possible causes which may prevent their juices from freezing. M. Aug. Pyr. De Candolle has investigated the action of these causes with his characteristic capacity.*

The causes to which this assumed resistance to freezing has been ascribed, may be reduced to *five*;—1. A certain amount of *proper heat* generated by physiological actions; 2. The viscosity of the juices lowering the freezing point; 3. The distribution of the sap through minute vesicles and capillary vessels depressing the point of congelation still further; 4. The warmth of the ground from which the sap is pumped up; 5. The low conducting power of concentric layers of bark with entangled air included in their meshes, and of the wood itself, which is less transversely than longitudinally. We shall examine the adequacy of each of these causes to account for the facts.

1. The experiments of J. Hunter, Schœpff, Bierkander, Pictet and Maurice, Schubler and Neuffer Hermstädt, Nau. Gœppert and others, have shown, that the interior of the trunks of large trees possesses, during winter, a temperature several degrees higher than that of the surrounding air. But, M. De Candolle and others have very reasonably doubted whether known physical causes might not be sufficient to account for the fact, without the necessity of ascribing it to the result of any physiological action. By recent experiments, however, made with instruments of great susceptibility to changes of temperature—such as the thermo-multiplier of Nobili—MM. Dutrochet, Becquerel and Breschet, have demonstrated, that in those parts of plants in which the vital processes are taking place with activity, an appreciable amount of caloric is constantly evolved. The amount of this evolution of heat is generally *very low*,—not more, in fact, than a *single degree* Fahr. in the herbaceous parts of actively-growing plants; and as it does not more than counterbalance the effect of evaporation, which is continually taking place from the surface, there is, under ordinary circumstances,—so far as *this cause* is concerned,—no sensible difference between the temperature of the plant and that of the surrounding atmosphere.† During the winter, when these functions are comparatively dormant, we cannot suppose that they operate at all in resisting any atmospheric changes which might be injurious to vegetation. Nevertheless, as vital changes are taking place with more or less activity at all periods,

* Physiologie Végétale, tome 3, p. 1101, et seq.

† Vide Ann. des Sci., N. S., tome 12. Also Carpenter's General and Comparative Physiology. 2nd ed. Lond., 1841. p. 417.

this may be regarded as a *vera causa*, but its effect, so far as the prevention of freezing is concerned, must be considered absolutely *infinitesimal*.

2. That the freezing point of the juices of plants is but *slightly* depressed below that of water, by the admixture of gum, mucilage, and other products of vegetation which impart viscidity to them, has been demonstrated by direct experiment. Hunter found the freezing point of vegetable juices when squeezed out of a green plant, to vary from 29° to 32° Fahr. In several experiments on the freshly expressed juice of the strawberry, I found the freezing point to vary from 28° to 30° Fahr.; and, in every case, the temperature *after congelation* was 30° Fahr. It is extremely probable, nay, almost certain, that the freezing point may vary with the degree of inspissation of the sap, and may, consequently, be different for different plants, and at different seasons of the year in the same plant; and, moreover, that it may, on this account, be somewhat lower in winter than in spring or summer. It is also probable, that the admixture of certain peculiar organic products may lower the freezing point of the sap of particular plants. Thus it is well known to chemists, that the point of congelation of good oil of turpentine is as low as 14° Fahr.; and, perhaps, the presence of this proximate principle, may tend to prevent the sap of the Coniferæ from freezing in moderate degrees of cold. In the present state of our knowledge, it is impossible for us to assign a definite *quantitative* value to the influence of *viscosity* in lowering the freezing point of the juices of vegetables; but it is certain that it cannot amount to *many* degrees of temperature.* It must have *some* influence, and must, therefore, be looked upon as a *vera causa* acting in the right direction; but in case of *extreme cold*, this cause is obviously *inadequate* to prevent the supervention of congelation.

3. Prof. Henslow seems to think that, "the chief protection against the sap freezing in the trunks of trees, is the circumstance of its being contained in extremely minute vesicles and capillary vessels; for it has been shown that water will resist a temperature of 16¼° Fahr. under similar circumstances; and all viscid fluids are still more difficult to freeze than water."† It is unquestionably true, that by taking certain precautions, water may be cooled 15 or even 20 degrees of Fahrenheit's scale below the proper freezing point, without the supervention of solidification. The

* The fact that the *specific gravity* of the sap of plants is but slightly above that of water, affords presumptive evidence, that the freezing point can be but little below 32° Fahr.; for experiments on the admixture of salts with water show, that the depression of the freezing point is nearly proportional to the increase of *density*. Knight found that the sap of the Acer plantanoïdes in the spring, collected close to the ground, had a specific gravity of 1·004; at seven feet above the ground it became 1·008, and at twelve feet 1·012. (Vide Phil. Trans. for 1805, pp. 90 et 91.)

† Op. cit. ante, p. 173.

essential condition of success in the experiment, is, that it must be cooled without the *slightest agitation*, and no angular body be in contact with it; for the instant any solid body is dropped into water cooled below its freezing point, or a *tremor* is communicated to it, congelation commences and the temperature starts up to 32° Fahr.* It is very obvious, that this *necessary condition* is most effectually secured, by placing the water in *capillary tubes;* for the adhesion of the fluid to the sides of the tubes, must tend to maintain it in that state of absolute repose upon which the success of the experiment depends. Thus Dr. Thomas Thompson succeeded in cooling water in thermometer tubes to 8° and once to 5° Fahr. before it began to freeze.† In the case of trees and shrubs, we have no means of ascertaining how far the *indispensable condition of absolute repose* may be subverted by the perpetual agitation to which their branches and more flexible parts are subjected, through the action of winds. But it seems to me, that in the case of plants, the distribution of the fluids through capillary vessels, can have but slight, if any, influence in the prevention of their congelation.

4. We have already alluded to the fact,—established by the experiments and observations of many distinguished physiologists,—that the interior of the trunks of large trees possesses, during winter, a temperature considerably above that of the surrounding atmosphere. It has, likewise, been shown, that this heat *is not* produced by the physiological actions which are taking place in the plant;—the amount generated by this cause being wholly inappreciable. M. Aug. Pyr. De Candolle very justly ascribes this uniformity of temperature of the interior of trees, to the circumstance of their roots penetrating the earth to a depth where the soil is always warmer than the atmosphere in winter and cooler in summer, and imbibing moisture which must necessarily partake of this influence. Hence it has been observed, that the internal parts of large trees, retain a temperature which is about equal to that of the soil at the mean depth to which their roots penetrate.‡ There can be no doubt that this is the chief cause of the uniformity of temperature of the interior of the *trunks of large trees;* but when considered as a resource against the effects of extreme cold, it is necessary to suppose that its protective action extends to the remotest branch and most minute twig. Now, it will hardly be contended by any one, that a small branch of a tree situated 80 or 100 feet from the ground will have its temperature appreciably modified by the tardy circulation of sap which takes place during the winter. In fact, direct observations

* Graham's Elements of Chemistry. Am. ed. Philad., 1843. pp. 50 et 51.

† Vide Heat and Electricity. London, 1830. p. 175.

‡ Physiologie Végétale. Tome ii, p. 879, et seq. Also, tome iii, pp. 1101, 1102, 1108.

show, that the temperature of the interior of small trees, shrubs and twigs, is sensibly the same as that of the surrounding atmosphere; and the difference becomes more apparent the larger the trunk on which the observation is made, and the nearer it is to the ground. It is manifest, therefore, that,—so far as the buds and smaller branches are concerned,—the cause under consideration, can have no *practical* influence in enabling vegetables to resist the action of excessive cold: its effect must be *infinitesimal.* Moreover, it will be shown hereafter, that perennial plants, and even large forest trees, endure the intense cold of a Siberian winter, *when their roots are imbedded in a soil which is frozen more than one-half of the year.*

5. After what has been said above, it is unnecessary to dwell on the influence of the bad conducting power of the concentric layers of bark, or on the greater facility with which the wood itself transmits heat longitudinally than transversely, as proved by the experiments of MM. Aug. de La Rive and Alph. De Candolle.* These circumstances only prevent the supply of caloric which is pumped up by the roots from the warm earth, from being carried off; but as we have shown, that no appreciable amount of this heat can possibly reach the extreme twigs and buds, it is sufficiently evident, that the low conducting power of the woody layers and bark can have *no sensible* influence in resisting any atmospheric changes which might be injurious to these portions of plants.†

It is proper to remark, that until quite recently, I participated in the opinion so generally prevalent among the most eminent physiologists, that the sap of trees and shrubs which are uninjured by extreme cold, is *never* frozen. I, therefore, entered upon the investigation with all my prepossessions in favor of the commonly received opinion in relation to this subject. Nevertheless, the *glaring inadequacy* of all the causes which have been assigned, to explain the presumed fact, induced me, during the winter of 1850–51, to institute a series of observations and experiments, with the view of obtaining clearer ideas. The sequel will show, that I was very soon driven to the conclusion, that the *fundamental idea* is erroneous, and that plants *do become frozen* without the slightest injury to them.

On the morning of the 18th of November, 1850, I found the leaves of the common garden cabbage covered with hoar frost on both surfaces, and so completely frozen as to be quite rigid and stiff. On more minute examination, it was found, that the

* Mém. Soc. de Phys. de Genève, vol. iv, p. 71; also, Ann. de Phys., xl, p. 91.

† These considerations seem to show, that those phytologists who are disposed to look at this subject in a teleological point of view, have mistaken the true office of the *scales* which envelop the buds of plants. They can afford no protection against the action of cold.

fluid contained in the petioles as well as that of the mid-ribs and lateral veins was completely frozen. By making a transverse or longitudinal section of them, the *icicles* could be scraped out with the edge of a knife. No indications of congelation could be detected in the parenchyma and smaller veinlets. At the time these observations were made, I had no thermometer with me;—but the weather was quite moderate;—the temperature at sunrise, could not have been below 28° Fahr. The cabbages were uninjured, although most of them were exposed to the direct action of the sun. Subsequently, the leaves of the Gardenia Florida were, on several occasions, observed to be frozen during the frosty mornings in December. They were curled backwards, and were so rigid as to break when an attempt was made to bend them. The foliage was not injured by this degree of cold, although it is by no means a hardy plant.

Doubtless, such facts are familiar to every practical horticulturist; nevertheless, I was anxious to ascertain whether the freezing ever involved the woody structures, and, if so, what was the effect on the plant. As the winter advanced, other opportunities presented themselves for extending these observations. On the morning of the 30th of January, 1851,—the temperature being 18° Fahr. —I examined the larger stems of a number of roses in my garden, and found the fluids of the bark and liber of all of them *completely frozen;—presenting a polished vitreous surface when cut by a sharp knife.* The fluids freely exuded from abraded portions of the bark, as soon as they were thawed by the warmth of the hand, or by removal to a warm room. The branches of the Pinus tœda,—some of them more than half an inch in diameter,—were found to be so brittle as to snap under a very slight degree of flexure. The fluids appeared to be congealed; for no gum exuded from the fractured extremity until it was brought into a warm atmosphere. These observations were repeated, and extended to other perennial plants, on the morning of the 31st of January, 1851,—when the temperature of the atmosphere was 13·5° Fahr.—with *precisely identical results.* It is almost needless to state, that the roses, pines and other plants examined were unmjured.

(*To be continued.*)

ART. XI.—*On the Drift of Lake Superior;* by E. DESOR.*

THE region of the great lakes may be considered as the headquarters of the North American drift. From the mouth of the St. Lawrence to the borders of Lake Superior, there is hardly a spot where the detrital formations are lost sight of. They generally form low, level plains, but sometimes rise in high bluffs and terraces, and again merely cap the promontories of the bolder cliffs. Throughout this long line of inland country there is, however, no place where they are more extensive than on the southern shore of Lake Superior—more especially its southeastern coast. There, they not only constitute the only visible formations for nearly one hundred miles, but they also attain an astonishing thickness, so as to form, by themselves, ridges and cliffs which exceed in height even those of the Pictured Rocks —being in some places (for example, at the Grand Sable) not less than three hundred and sixty feet high. In consequence of this preponderance of the drift deposit, that portion of the shore of the great lake is the least attractive in a picturesque point of view—it being in the nature of the detrital deposits to soften down the contrasts, and to produce uniformity and monotony. The drift is less conspicuous along the western portion of the lake shore, although it is not wanting even among the romantic and precipitous cliffs of the Pictured Rocks and the Red Castles.

* * * * * *

The drift of Lake Superior may be divided into four different deposits, which, in an ascending order, exhibit the following characteristics:

1st. A layer of coarse materials, composed of pebbles intermingled with loam, which we will designate as coarse drift.

2d. A layer of clay resting either on the coarse drift, or, where this is wanting, on the rock. This is the drift clay of Lake Superior.

3d. A deposit of sand, gravel, and pebbles, irregularly stratified, resting upon the clay, or sometimes upon the rock itself.

4th. A considerable number of isolated boulders, scattered over the whole region, forming the uppermost portion of the drift deposits. The polished and grooved surfaces which occur in connection with the drift constitute, likewise, a most important feature in its history. Finally, there are the drift terraces and ridges, which likewise deserve a close examination, in order to ascertain their bearing in reference to the changes of level which have taken place during and since the drift epoch.

* From the Report of Messrs. Foster and Whitney; revised for this Journal by the author.

1. *Coarse drift.*—This deposit is the least conspicuous of all. It is found only in a few places along the southern shore of Lake Superior, generally capping the high towering cliffs of sandstone, (as, for example, at the Red Castles, west of the Portage, and also at the top of the Pictured Rocks.) It is generally a mixture of loam and fragments of rock of different size—sometimes worn, but more generally angular. As a leading feature, we may state that it is almost exclusively composed of fragments of the rocks *in situ*, showing that, whatever may have been its origin, it could not have been acted upon by long continued agencies. After a careful examination, I found but few foreign pebbles, mostly of trap, scattered through the mass, and evidently derived from the neighborhood. The whole mass is nowhere more than thirty feet thick. We ought to add further, that in many places the pebbles may be seen disappearing gradually, and the whole passing into a regular drift clay.*

2. *Drift clay, or red clay.*—This deposit was long ago recognized as a peculiar one, distinct from the drift-gravel and sand above it, and the coarse drift beneath it. It has been described by the geologists of the Michigan state survey as the "tertiary clay of Lake Superior." From its red color, which is one of its leading features, it is also called by some "red clay." It is difficult to determine its average thickness, from the fact that, in many places where it is highly developed, it sinks below the waters of the lake, and in other cases, where its base is visible, its top has been partly washed away. There are, however, some places (for example, at the western portion of the Grand Sable) where it may be seen undisturbed in its natural position, its base resting on the almost horizontal strata of red sandstone, a few feet above the water, whilst its top is covered by a considerable mass of drift sand. I found the deposit in this place to be sixty feet in thickness, and exhibiting distinct lines of stratification. Its upper limit may be here seen stretching in a horizontal line for a long distance. We may well consider this locality as indicating the average thickness of the clay. However distinct the upper limit of the clay may be in general, it is also seen in many localities alternating with the sand above, or passing gradually into it—thus showing that both deposits, although of different materials, belong, nevertheless, to the same formation, and therefore that there is no real ground to consider the clay as being a part of the tertiary formation. As far as its composition is concerned, it appears to be a mixture of loam and clay, and its color is owing to the decomposition of the red sandstone and trap from which it has been derived. Though the main mass of the clay

* This deposit might, perhaps, seem hardly worth mentioning, were it not that its peculiar structure and its position remind us of a similar deposit widely diffused throughout New England, especially in the mountainous districts of Vermont, where it forms the most conspicuous feature of the drift.

stratum is composed of very finely comminuted substances, and oftentimes reduced to an almost impalpable powder, yet there are many pebbles interspersed through it, and even boulders of considerable size, generally rounded and smoothed. Fragments of metallic ores and native copper occur occasionally in it—the latter sometimes weighing several hundred pounds. It was by means of the fragments of copper scattered through the clay that the attention of the early travellers was first attracted to the copper mines of that region, which are now so extensively wrought.

* * * * * * *

As to its extent, it appears, from what we know, to be spread over an immense tract of country. Not only is it found along the whole southern coast of Lake Superior to Fond du Lac, and along the St. Louis river as far as geologists have extended their investigations, but it occurs also on the north shore, where it has been traced for a considerable distance along several rivers which empty into the lake. It was observed, however, by Mr. Whittlesey, that to the northwest of Lake Superior the drift assumes an ash-colored tint, which is owing, no doubt, to the absence of red sandstone in these regions.

If we were to consider merely the position of this clay as it appears on the southern border of Lake Superior, forming, as it does, a regular stratum, resting upon the red sandstone, and being limited to a certain height, where it is followed by the drift sand, we might well conclude that it was deposited in a circumscribed basin. This is, indeed, the impression which a traveller might receive if he were merely to coast around the lake. Such an impression would be, however, entirely erroneous; for, in ascending the highlands which rise behind those cliffs, we meet again with the same clay at an elevation of from six to eight hundred feet—as, for instance, near the Jackson location on Carp river, and in several places along the road leading to it. It also forms lofty cliffs on the river Ontonagon. In all these places its composition is the same as along the lake shore, being quite as comminuted, and forming the same sticky loam when wet. It ought to be observed, however, that, on the whole, it seems to be limited merely to the depressions of the soil, and never to cover the culminating points.

3. *Drift sand and gravel.*—This is the most widely diffused of all the drift deposits along the shore of Lake Superior, as well as over the whole northern part of the country. It not only covers the clay deposit in most of the localities where the latter has been observed, but also extends over many places where this does not reach. We have stated that the clay, even at its highest level, was generally limited to the depressions. The drift sand and gravel have no such limitations. It is found on the uplands and along the slopes of the hills, as well as in the depres-

sions. Although separated from the drift of the western prairies by the dividing ridge between the upper peninsula of Michigan and Wisconsin, yet in many places, where the ridge is not of considerable elevation, it may be seen passing directly from one slope to the other, especially on the southeastern corner of the lake. It is likewise said to pass from one slope to the other at the southwestern border between the lake and the headwaters of the Mississippi. It is found on the highest summits of the Pictured Rocks—nearly two hundred feet. Its relation to the drift clay can be easily ascertained merely from the state of the roads and trails, which are generally dry and pleasant on the drift sand.

No rule obtains as to the composition of the drift sand and gravel, either in reference to the size or the mineralogical character of the materials.

Layers of fine sand alternate in every possible way with layers of pebbles—sometimes by a gradual transition, at others rather abruptly. The pebbles themselves are composed of all kinds of stone—some from the immediate neighborhood, others from places more remote. They are generally rounded and smoothed, showing that they must have undergone a prolonged and violent motion, such as could have taken place only in the water. The same is the case with the boulders imbedded in the mass, of which there are many of considerable size—from five to six feet through. Many of the boulders are also covered with scratches, such as could have been produced only by a violent and steady rubbing. We would state, besides, as a further peculiarity of the drift pebbles and boulders, that they are generally clean, there being no loam or mud attached to them—a peculiarity which is in itself sufficient to distinguish the gravel drift from the loam deposits of coarse drift before described. The thickness of the drift-sand and gravel, like that of the clay, is best ascertained along the shore of the lake. There seems to be a sort of antagonism as to the relative thickness of both deposits between the eastern and western portions of the lake shore. Whilst the clay seems to assume its greatest thickness west of Keweenaw Point, the sand and gravel seem most developed to the east of that point. Its greatest thickness we found to be at Grand Sable, where the coast rises, according to Mr. Whitney's barometrical measurement, 360 feet above the lake; and since the clay stratum underneath is only sixty feet thick, it gives an amount of three hundred feet for the sand and gravel deposit. From that spot the same drift may be seen extending in the form of a high cliff to the southeast, generally some miles distant from the lake shore; until it reaches it again at Pointe Iroquois, where it rises almost to the same height—345 feet; thence it sinks gradually towards the Saut. As a further peculiarity of the drift-sand and gravel deposits we would mention their irregular and undulating surface, especially where they cover wide tracts of country: as,

for instance, in the plains of Wisconsin and Illinois, which from this feature, have been denominated *rolling prairies*, in opposition to the level prairies, which are mostly alluvial. The shores of Lake Superior are, in this respect, less striking—owing, no doubt, to the fact that the country is less level, and also in consequence of the forests which almost everywhere cover the ground. The summit of the Grand Sable, as will be noticed subsequently, is the place where this undulating appearance is most striking on the lake shore.

There can be no doubt that, as a whole, the drift sand and gravel is a stratified deposit, although the stratification is perhaps more imperfect than in any other sedimentary formation. The strata are generally most distinct where the mass is composed of fine sand. They are less conspicuous in the gravel, except where it alternates with layers of sand or clay, in which case the separation into layers is sometimes very distinct. As a frequent occurrence, we would especially mention those irregular layers which have been designated under the name of *cross-stratification* by some, and of *discordant stratification* by others. There may be sometimes seen in a single section, three, four, five, and even more planes of stratification, forming among themselves all sorts of angles—some horizontal, some slightly inclined, and others almost vertical. Instances of such stratification are to be seen all along the coast of Lake Superior, in the drift as well as in the alluvial sand. They are less frequent where the deposits assume a more loamy character. It is well known that this discordant stratification is not limited to the quarternary deposits, but occurs in sandstone of every age. Along Lake Superior, where the drift deposits rest immediately on the Potsdam sandstone, it is a rather impressive sight for a geologist to witness, this structure both in the oldest and most recent of the sedimentary formations, side by side, thus showing that the same laws of deposition, even in minor details, have prevailed at all times in the formation of the earth's crust. Some doubt still exists as to the cause of these singular stratifications. The attention of geologists was first directed to them in the recent deposits of the valley of Switzerland, where two rivers (the Rhone and Arve) meet. They were ascribed by M. Necker to the disturbance caused by the meeting of two currents of variable strength, contending with each other in the same bed, whence the strata resulting from this conflict were called *stratifications torrentielles*. In this way the Swiss geologists succeeded in explaining, not only the variable inclination of the strata, but also their difference of materials, when it happens that one of the currents carries coarser substances than the other. It is evident, however, that this explanation does not apply to the similar structure of the sand deposits along the sea and lake shore, where the conflict is no longer

caused by rivers, but by the contending forces of waves and currents. We know, for instance, that in some shallow harbors—that of Charlestown, for example—the pilots have to make out the channel after every severe gale. This shows that the waves exert a strong influence upon the bottom, where it is shallow enough to come within their reach; and since, from the nature of the waves, we must suppose their action to be broken and unsteady, we might well expect such irregular strata to be formed wherever the waves and tides come in conflict. Along Lake Superior there are no tidal currents, as far as we know; but the currents resulting from the changes of the wind are strong enough to account for similar conflicts. If this explanation be true, we might then expect such discordant stratification wherever the water is shallow enough to allow the bottom to be stirred up by the waves. Indeed, there is every probability that all sand and sandstone formations which exhibit a similar structure have been formed in shallow water—an inference which, as far as the drift is concerned, is confirmed by other considerations, which we shall examine hereafter.

4. *Boulders.*—Of all the drift deposits, the boulders have, from all times and in all countries, excited the greatest interest, in consequence of their size, as well as of their position. The mere view of a huge block of granite, situated, as it often happens, on the summit of a hill, whilst the rock on which it rests is of limestone or sandstone, is sufficient to excite the curiosity of every thinking man, as to the place from which this stranger may have come, and as to the mode by which its transportation was accomplished. We ought not to be astonished, therefore, that most of the theories which have been imagined to solve the problem of the drift should refer chiefly, if not exclusively, to the boulders. From looking at them in a too exclusive point of view, most geologists have misunderstood their true signification; they have overlooked the other more regular deposits with which they are connected: thus forgetting that the boulders form but a part of the drift formation, and represent but one single though striking event in a long period of the earth's history. This we consider the chief cause of the insufficiency of most of the theories. Before we attempt any explanation, our object will be first to examine their peculiarities, as exemplified in the region of Lake Superior—which we deem the more important, as this region seems to have been the point of departure for many of them, scattered far and wide over the country. Boulders of every size and description occur in great numbers along the whole southern shore, and are said to be as numerous along the north shore. As a whole, they did not strike me by their dimensions. They do not by any means equal those huge masses found in Switzerland and in many parts of New England. The largest boulder which

I noticed was one of hornblende, near Carp river, measuring fifteen feet in length, eleven in width, and six and a half in height; another, near the Portage, measured eight and a half feet in length and five in width. On the borders of Lake Superior, as in all other countries where drift occurs, the boulders are the most widely diffused. They are scattered over the whole country, and may be seen at all heights, where no other drift deposits reach. They are truly the vanguard of the drift formation, in height as well as in space. Even the dividing ridge, where it rises the highest, does not limit their extent; for they have been found as high as one thousand feet above the lake south of the Anse, and may from thence be traced uninterruptedly along the southern slope of the ridge into the prairies of Wisconsin and Illinois. As to their mineralogical composition, there is every variety of rocks to be found, and in many instances they may be traced to their origin at no very great distance. We thus soon accustom ourselves not to look any longer upon them as strangers, as we do where there is no analogy whatever between them and the rocks on which they rest. Among the most numerous boulders along the lake may be mentioned those of granite, trap, and hornblende rocks, which are common to both shores. Boulders of sandstone are less frequent, in spite of the great predominance of this rock along the south shore—a circumstance easily accounted for by its greater softness, which renders it the more destructible. As a general rule, it may be stated that most of the boulders scattered over the Lake Superior region have not come from far. This is of the utmost importance, since it actually enables us to trace the route which they have followed; and as to their direction, I feel no hesitation in affirming that most of the boulders within the region of Lake Superior have been transported from north to south. As instances of this southerly transportation, I shall state the following facts. The iron region of Lake Superior is situated near Carp river, east of Keweenaw Point; and, although the ridges where the iron ore occurs are only some ten miles from the shore, yet there is not a single boulder, nor even pebble, of iron to be seen north of the ridges. This ore, of which there are innumerable fragments scattered at the foot and in the immediate vicinity of the ridges, is so conspicuous, from its banded structure, that it would undoubtedly have been noticed, if it did occur at all north of its origin. In going from the iron ridges towards the south, iron pebbles and boulders occur in abundance, and may be traced for some distance. Thus, in September last, Mr. Whitney, starting from the ridges east of the Jackson location, traced boulders of iron ore all along his route towards the Esconaubee river, some twelve miles off; and they might probably be found still further south, were it not for the swampy character of the country. This southerly

transportation is further confirmed by the boulders of the beach itself, which point likewise to the north as their birth-place. This applies especially to the copper region west of Keweenaw Point. There trap and sandstone are the only rocks in place; and yet among the boulders scattered over the surface there are many of granite and hornblende, which have evidently their origin on the opposite shore, where we know these rocks to be very abundant. Thus it happens that, when travelling from south to north, the appearance of a new formation is always indicated by the occurrence of single boulders of it, whilst nothing of the kind takes place when travelling from north to south. This precession of the boulders is especially striking among the ridges of the iron region north of Carp river, where there is often a great variety of structure in the rocks of the different ridges. There the valleys between the different ridges contain, for the most part, boulders from the next ridge to the north. There are also instances where a ridge did not allow the fragments of the preceding ridges to pass. A striking instance of this has been observed by Mr. Hill west of Jackson location, where the slate and iron boulders are heaped up in great quantities on the northern slope of a greenstone dyke, whilst there are none on the granite slopes south of this dyke, which has therefore acted as a barrier, preventing their transportation farther south. This limitation prevails, however, only within the hilly portion of the Lake Superior region, between the lake shore and the dividing ridge. South of the ridge nothing of the kind seems to occur. There being no further barrier to check their course towards the south, they have travelled even to the very limit of the drift deposit; and thus it happens that boulders of the Lake Superior region are found as far south as the Ohio—that is to say, more than six hundred miles from the dividing ridge, the nearest place from which they could possibly be derived. We think, therefore, that there is satisfactory reason to consider the region of Lake Superior, and especially the rim of cliffs and hills which surrounds its basin, as the birth place of the greatest quantity of boulders scattered over the western States of the Union between the Alleghany mountains and the Mississippi; and from this consideration, the region of Lake Superior, more than any other, deserves a close attention on the part of the geologist who attempts to solve the problem of the drift of this country. By far the greatest quantity of boulders on Lake Superior, as well as elsewhere, are situated on the surface, above all other drift deposits. This, of course, is in itself a proof that they have been deposited posteriorly to these formations. But because they are of a more recent origin, this does by no means prove that they are disconnected from the other drift deposits. We have seen that an abundance of boulders is to be found both in the drift clay and

sand of Lake Superior. The only difference between them is, that whilst those of the surface are often more or less angular, those imbedded in the clay and sand are generally more rounded, and often scratched and striated—a peculiarity which we shall afterwards attempt to explain. Now, as the boulders within the drift are of the same kind as those of the surface, and have, like them, a northern origin, (though sometimes not a great way off,) we are naturally led to the inference that they were transported by the same agencies, which must, therefore, have been at work during the deposition of the drift period. Moreover, these agencies must have been as powerful at the time of the drift and clay deposits as afterwards, since we know that many of the included boulders are as massive and as heavy as those of the surface. It is evident, therefore, that no theory can be admissible which does not at the same time account for the transportation both of the boulders of the surface and those of the drift sand and clay.

5. *Grooved, scratched, and polished rocks.*—Whatever opinion we may entertain as to the cause and origin of the drift, there is a point upon which all geologists who are familiar with the subject agree, viz: that there is an unquestionable connection between the drift deposits and the rounded, smoothed, and grooved appearance of the rocks upon which they rest. Wherever drift occurs, it is associated with that peculiar appearance of the ledges, which is instantly recognized. The surfaces are the more perfect, as the rocks are harder and less prone to disintegration. Thus in our district they are most distinct on the trap and compact slates; less so on the granite and compact limestone; and are not expected to be found on the sandstone. Again, in many places the striæ and furrows have disappeared in consequence of the disintegration, and there remains nothing but the rounded outline of the rocks, which, from their resemblance to fleecy clouds, have been called, in the Alps, fleecy rocks.

In many instances the polished and grooved surfaces are concealed by the drift, and are not visible until by some means the deposit is removed. This explains sufficiently why so general a phenomenon should have been for so long a time overlooked by geologists; for it is only about forty years since it was first mentioned, and only ten years since it was brought into general notice. One striking peculiarity of the rocks subjected to erratic agency consists in the fact that, while one side is smoothed down, the opposite side is rough and angular, as if it had been sheltered from the abrading process. These are known as the lea and strike sides. By means of this feature we are enabled to recognize the direction in which the erratic agency operated, even where there are no scratches. The lea side is invariably to the south over the whole of this district—a feature which we ought to expect, when we consider the origin of the groovings.

As a leading feature of all groovings, we may mention their straight course. Whatever the direction, they are in straight lines, whether continuous or interrupted—thus showing that they must have been formed by an agency unyielding and steadily applied. There is but one instance where curved striæ have been observed in this region, which will be noticed hereafter.

Groovings of all sizes occur. The most common form is that of parallel furrows from one to two and four lines wide—sometimes extending but a foot, at others many yards. Where the rock is excessively hard they are mere striæ, which are often as distinct and sharp as though they had been graven with the point of a diamond. Hollow spots are observed, as though they had been scooped out by a round instrument; also, we observe wide bowl and trough-shaped depressions, which have been caused by the same agency, since they are always found parallel with the striæ. Instances of all these different forms exist on both shores of the lake and on Isle Royale.

As to the direction of the striæ in this district, it will be seen that, with the exception of a few local deviations, it is northeast and southwest—a direction which also prevails along the western shore of Michigan, and in portions of the western States. This direction forms a striking contrast with that which prevails throughout New England. There, they bear northwest and southeast. We shall hereafter attempt to explain this singular opposition in the striæ of the two regions east and west of the Alleghanies, and show their relation to the leading features of the continent.

6. *Terraces and Ridges.*—The terraces and ridges of the great lakes have of late attracted a good deal of attention, inasmuch as they have a direct bearing upon the question of the changes of level which the surface is supposed to have undergone during the epoch of the drift. They may be seen both on the south and the north shores of Lake Superior, though they are less striking here than around the lower lakes, (Erie and Ontario.) Those of the north shore of Lake Superior have been described by Mr. Logan. They are most conspicuous at a locality called "Les Petits Ecrits," of which Mr. Eliott Cabot has given a fine sketch in his Narrative. Those of the south shore have thus far been but little noticed, probably because they occur chiefly in that portion of the lake-district which is least visited, viz.: between the Saut and Keweenaw Point. Beyond that point, there may be seen, in many places, along the shore of the copper region, high bluffs of drift; but they nowhere assume that stair-like form which is the characteristic feature of terraces.*

* To avoid confusion, it may not be inappropriate to explain what is meant by the terms terrace, bluff, and ridge, as we shall have to allude frequently to them in the following descriptions. Drift bluffs, or cliffs, are those accumulations of loose materials which terminate abruptly in steep slopes. The steepness of the slope de-

In a geological point of view, the terraces are the most important, since they afford direct evidence of the changes of level which have occurred since the deposition of the drift. There can be no doubt that, wherever terraces of stratified materials are found above each other, the waters have once stood at so many levels. It might be, and indeed it has been, inferred from this, that when terraces occur along a shore, they ought to be found everywhere of the same size; and hence, that when their level is irregular, it is a proof that the upheaval was not uniform. This view, although correct in principle, is, however, apt to lead to mistakes when applied without discrimination.

The error in this respect arises from the fact that terraces have been too often mistaken for, or confounded with, mere beaches. It should not be lost sight of, that terraces and bluffs are the result of the undermining action of the waves. Their size and shape must therefore be determined by the force of this agency. If a basin of water is so situated as to have one of its shores exposed to the full force of gales, while the opposite shore is sheltered by high lands, we may easily conceive of a subsidence of the waters from a higher to a lower level, without at all altering the slope of the coast. In the mean time, the right shore, not being protected, will be so acted upon as to occasion a succession of terraces. Again, the destructive action may be so effective in certain places as to wash off, in the course of time, even the terraces of former levels, and to leave only a single bluff.

There are many places along the lake shore where the peculiar shape of the terraces and their diversity are to be ascribed to such a process. The annexed diagram will render this still more evident. There can be no doubt that the water once stood at the foot of the upper terrace, *m*, and that, while stationary, the upper bluff was formed. Afterwards, the water-level sank, and another bluff was formed at *n*, and still later, another at *o*. The subsidence of the water must have been intermittent—the epochs of subsidence, which are indicated by the areas between the terraces, being followed by intervals of quiet, during which the terraces were formed. But this regular succession of terraces does not extend far. It is limited to a

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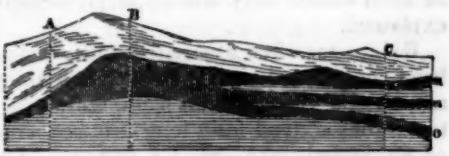


pends in most cases chiefly upon the kind of materials of which the bluff is composed. Thus, bluffs of clay are steeper than bluffs of loam, and bluffs of loam steeper than bluffs of sand or gravel. The term terrace is applied when several such slopes are seen one above the other, so as to appear like the steps of a staircase. Ridges differ from terraces in having a double slope, and being, therefore, real hills; whereas bluffs and terraces are merely the margins of plateaux.

small space in our diagram; and as we advance towards the left, we see the intervals between the terraces growing more and more narrow, till they completely disappear—being, as it were, crowded into a single bluff, B. Further on, we see the bluff itself increasing rapidly in height, and by-and-by disappearing entirely, leaving nothing but a gentle uniform slope, A. In the above instance, the circumstance that these different forms of terraces occur within a narrow space, and pass gradually into each other, excludes at once the idea of a change of level. It must be evident to any one that they cannot but be the result of local causes. But, should they occur at great distances, such differences might easily lead to error, and in the present case we might infer that the three terraces *m*, *n*, *o*, were raised at three successive intervals. Thus, not taking into account the action of the waves, and the position of the shores in reference to the predominant winds, (as exemplified in our diagram,) we might perhaps be induced to recur to extravagant hypotheses, call in aid even the trap dykes, and other paroxysmal agencies, to account for features which are most readily explained by the mere play of meteorological agencies.

However, we do not pretend to assert that the upheavals which laid bare a great portion of the drift deposits have been uniform throughout. We know that there are, in almost every drift country, undoubted proofs of local changes of level afforded by the drift terraces; and we shall have occasion hereafter to refer to such an origin for those differences of level which are to be traced in an uninterrupted manner over vast tracts of country, especially along the sea shore. But we should be careful to call in such causes only when the phenomena cannot be otherwise explained.

Ridges are often associated with terraces, and have frequently been confounded with them. They differ from terraces in being actual hills, rising from a plain, with a slope on each side. Sometimes they extend for a long distance along the shore of the sea, or an inland lake—as, for instance, Lakes Erie and Ontario, where they are commonly used as roads, being dryer than the surrounding grounds. From their situation, as well as their position, these ridges have the greatest analogy to ancient beaches, and there can be no doubt that many of them have no other origin. In that case they are the most reliable evidence for ascertaining local changes. Beaches have almost uniformly gentle slopes, rarely exceeding 12°; but there are among the ridges some which are too high, with slopes too abrupt, to be considered as mere beaches. Since attention was first attracted to them in Sweden, where they go by the name of *æsars*, (which means sand hills,) I shall designate them henceforth by that name. There is every probability that they were formed as shoals, or

bars, or banks, under water, rather than on the border of the coast, since we know that such ridges are forming in our day in shallow water both in the sea and large lakes. It ought to be remembered that the summit of these submarine ridges is not always even, nor their bearing necessarily horizontal; so that a slight inequality in their outlines, especially if limited to a narrow space, does no more imply a local change of level than in the case of the terraces before mentioned. Since, from the nature of things, raised beaches and œsars are expected to occur in the same localities, it must be left to the sagacity of the observer to determine in each case to which class they belong. Instances of both have been noticed, at numerous points, along the shores of the lower lakes, but they are less frequent on the coast of Lake Superior, although not entirely wanting.

Conclusion.—It is not intended here to give a general theory of the causes and origin of the drift, since it would oblige us to allude to many phenomena foreign to the district under consideration, and to discuss the many systems which have been proposed by various authors to solve this great problem. I shall, therefore, limit myself, for the time, to a brief sketch of the principal periods which may be recognized among the drift deposits of Lake Superior. A mere glance at the relative position and structure of the drift deposits, as described in the foregoing pages, will suffice to prove that the phenomena neither indicate a paroxysmal agency, nor the operation of a single cause, however long continued. They disclose a long series of events, which have resulted from causes highly diversified, and as yet but imperfectly known. We recognize the following periods in the history of the drift of Lake Superior:

1. The period of the grooving and polishing of the rocks must be considered as the dawning of the drift epoch. At the close of the tertiary era, (which has left traces of its presence over many of the States bordering on the Atlantic, as far north as the island of Martha's Vineyard, in Massachusetts,) the whole northern portion of the continent was subjected to the operation of a general and most powerful agency, of which there is no precedent in the history of former geological ages. There may be found in every sedimentary formation, deposits similar in their composition to those of the drift, but the rocks on which they rest are nowhere characterized by those peculiar markings which we have described as glacial furrows and striæ. In the region of Lake Superior, they are found at all levels—over plains, and on the slopes of the hills and mountains. Even the dividing ridge between the upper peninsula and Wisconsin exhibits traces of their action. It is proved that here, as well as in Europe, their main direction has been from north to south—being, however, some-

times deflected either to the east or to the west. These deflections are, no doubt, dependent upon the leading physical features of the country. Along the south shore of Lake Superior we have found them running mostly from northeast to southwest, a direction parallel with that of the principal ridges—as, for instance, those of Isle Royale and Keweenaw Point. These coincidences would be still further strengthened, if it could be ascetained by a series of soundings across the lake, that the main troughs run in the same direction.

We know, in the actual operations of nature, of no agent capable of producing such a gigantic result as the shaving and smoothing of a whole continent. To those who are familiar with the effects produced by glaciers upon the walls and bottoms of the valleys through which they move, it cannot be denied that they exhibit the closest analogy to the phenomena which we have been describing. The appearance of the rocks, as well as the form and size of the striæ, is the same; yet it must be remembered that, in our days, glaciers occur chiefly in the valleys of the highest mountain chains.* It is, therefore, difficult to conceive how they could exist and move in a wide and level country, like the northern parts of the United States and Canada. In order to avoid this difficulty, it has been assumed that the whole northern hemisphere, as far as erratic phenomena reach, was once covered with a general cap of ice, similar to that of the circumpolar region, which in its southerly progression, is supposed to have at once smoothed the rocks and transported the boulders from north to south.† A careful examination of the position of the boulders, which I have found, both in this country and northern Europe resting mostly on stratified deposits of sand or clay, has convinced me that the above assumption is no longer admissible, so far as it relates to the transportation of the boulders. The remaining question relates to the grooving and polishing of the surface rocks. However inclined I may be, from personal observation of the glacial phenomena both in Switzerland and Scandinavia, to refer the groovings to this agency, according to M. de Charpentier's theory, (which is also advocated by M. Agassiz,) I shall refrain from entering into any discussion of the subject, for the reason that the laws which regulate the motion of the polar ice are as yet too little known to be made the basis of geological speculation in a report like this, the object of which is to state facts and give particular information. Whatever may

* I have shown elsewhere that the glaciers of the Alps are as much dependent upon the orographical features of the Alps, as upon the climate. See Comptes Rendus, de l'Académie des Sciences.

† As to the difficulty arising from the climate, I would remark that it has been most ingeniously shown, in a recent paper by M. Lecoq, that if polar glaciers have ever existed in these latitudes, it was possible only with a higher temperature.

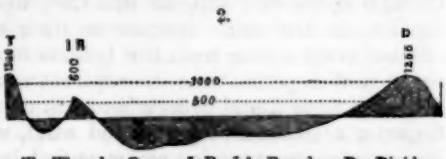
have been the cause of the groovings, it must be admitted that an agency which was capable of shaving off and wearing down such an extent of surface must also have been able to remove the detritus and to transport it from one place to another. I am inclined to ascribe this agency, and to consider as contemporaneous with it, that portion of drift materials which I have described as coarse drift, and which, wherever it exists, is regularly found at the base of the stratified deposits, having been left undisturbed by the waters of the subsequent period.

2. We have shown that almost everywhere along the southern shore of Lake Superior there is a stratum of red clay resting on the coarse drift, or, where this is removed, on the polished rocks. From its thickness and the comminuted state of the materials, we infer that during its deposition a long interval of time elapsed, characterized by no violent agitations. With this stratum begins the second era of the drift. As to the boulders distributed through it, we may suppose that they were transported by floating ice, in the same manner as their transport is at this day effected every spring from the borders of the northern lakes and rivers, and dispersed over the adjacent swamps and low lands.

3. We have found everywhere resting upon the clay of Lake Superior a stratum of gravel and sand, which, notwithstanding its irregular structure, is a real stratified deposit and must therefore be supposed to have been formed in water. Occurring at still higher levels than the drift clay, and attaining sometimes a thickness of several hundred feet, we must suppose that at the time of its deposition the country had subsided to a still lower level. From the diversity of its stratification we infer that this period was characterized by intervals of agitation and repose. According to Mr. H. D. Rogers's ingenious theory, this feature should be ascribed to the temporary operation of earthquake waves, such as are known to occur occasionally in our days, especially in the Pacific. Such waves might well have disturbed the bottom of the ocean, carrying before them an immense freight of detrital materials, which were heaped up in irregular masses and hills, resembling the drift accumulations.

I consider, as belonging to the close of this period, the transportation of those huge boulders which are scattered in such vast profusion over the surface of the gravel deposits, and which we have detected on the very summits of the anticlinal axis, where no other drift deposits occur. It might thus appear, at first that this epoch had been characterized by more violent agitations than the preceding one. We should be careful, however, not to judge of the power and violence of an agency merely from the size of the materials transported; for, if the boulders had been conveyed by powerful currents, we should not only find them of diminished size in their progress southward, but also rounded and

smoothed like the smaller pebbles. On the contrary, we know that they are just as massive at the very limits of the drift in Ohio, as near their birth-place; besides, many of them along the anticlinal axis are perched, as it were, on the very top of narrow hills and knobs, where it is hardly admissible that they should ever have been left by a violent agency. Finally, many of them, in spite of contradictory assertions, have rather sharp angles, as if they had been subjected to but slight attrition. I am therefore inclined to suppose that the surface boulders, like many of those buried in the drift-clay and sand, have been transported by floating ice, (not icebergs.) By this hypothesis, their position on the summit of the hills offers no longer any difficulty; for it is natural to suppose that they should have been stranded upon those points, which at the time were shoals. The changes of level which the region of Lake Superior has undergone during the drift epoch are represented in the following diagram. Assuming that, during the period of the groovings, the waters stood nearly at the same level as now, the land must have sunk during the second period to the depth of at least five hundred feet, and again the same amount during the third period, when they reached those summits, which are now one thousand feet above the lake.



T., Thunder Cape. I. R., Isle Royale. D., Dividing-ridge between Lake Superior and Lake Michigan.

The boulders of Lake Superior, like those of all other parts of the country, point to the north as the source of their origin; yet there is this difference, that they are not generally derived from far. Those along the beach of the south shore have in the main been derived from the north shore, but as a whole they are not very numerous; and I have Mr. Foster's authority for stating that very few have passed beyond the dividing ridge. The boulders and pebbles of the opposite slope of the axis, although more numerous than on the northern slope, are all derived from the dividing ridge itself. The same is true to a great extent of those scattered over the plains and prairies of Wisconsin and Illinois. This ridge, abounding in eruptive and metamorphic rocks, is therefore to be considered henceforth as the true birth-place of the boulders scattered over the Western States, and we need no longer recur to high northern latitudes to ascertain their origin.

The drift epoch may be considered as closed with the transportation of the boulders. The waters, after having thus reaching their highest level—during which the transport of the boulders and pebbles was accomplished—again subsided. With this subsidence commences the era of the alluvium. We have no reason

however, to suppose that the subsidence was sudden. Everything leads us to believe, on the contrary, that it was gradual, and that the same agencies continued to operate to a certain degree. Thus we may infer that beaches were formed, sand bars built up, and boulders transported, in the same manner as before, although at lower levels. Meanwhile, the former and higher beaches receded more and more from the shores; the bars, shoals, and submarine banks appeared as ridges or œsars above the plains recently laid dry, whilst new ones were forming at lower levels; and whenever the water, in its receding movement, stood for a sufficient time at the same level to allow the new shore to be acted upon and undermined by the waves, these bluffs and terraces were formed, as shown before.

Now, since terraces and ridges occur frequently along the great lakes, they may be considered as a conclusive proof that the subsidence was really gradual. In this respect, terraces and ridges, although composed of drift materials, belong properly to the alluvial period, as well as the denudations along the channels through which the waters are supposed to have been discharged. I shall therefore examine them with more detail in my report upon the alluvium. Thus far, we are not aware of any striking geological event—such as the elevation of a mountain chain—having taken place between the two epochs of the drift and alluvium. It might therefore be asked if there is sufficient reason to separate them. There are, indeed, some geologists who question the propriety of such distinction. My chief motive in adopting it is derived from all of the drift phenomena, rather than from any single event.

The drift is the last phasis of any importance through which the earth passed before it became fitted for the habitation of man. Were it not for these deposits, a great portion of this continent, including the district embraced in this report, would have been a waste of naked and barren rocks, covered partially with heaps of dry sand or rough detrital materials. Through the long continued agency of water, these materials have not only been reduced and dispersed, but also mingled in such proportions as to afford a most appropriate soil for vegetable and animal life. When, afterwards, the rise of the continent caused the waters to recede within their present limits, they left behind them those wide, drift-covered plains, destined to become, in the lapse of time, the seat of an industrious, intelligent, and prosperous nation. We think ourselves justified in considering the period, when the waters, after having done their work, began to recede, as the beginning of that new and grand era which has been properly called the era of *man*, and of which the alluvial period is the introduction.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Magnetic relations of Gases.*—Plücker has studied the magnetic and diamagnetic relations of various gaseous bodies in different states of pressure. The apparatus employed consisted of a delicate balance, the beam of which was of glass and which gave a perceptible deflection with 0·0001 milligramme. The gases examined were enclosed in spheres furnished with stopcocks and attached to one of the arms of the balance; these were capable of resisting an internal pressure of about two atmospheres. The sphere of glass containing the gas was placed over the two half-armatures of a powerful electro-magnet and then the attraction or repulsion measured by means of weights placed in the opposite scale pan. The trifling amount of magnetism in the glass was exactly compensated by the magnetism of the surrounding air. The following were the principal results obtained.

(1.) The specific magnetism of oxygen compared with that of iron as unity was found to be 0·003500.

(2.) Oxygen loses its sensible magnetism in almost all gases where it enters into chemical combination. Deutoxyd of nitrogen, NO_2, is an exception to this rule, its magnetism being $\frac{2}{3}$ths of that of oxygen.

(3.) If we introduce oxygen little by little into a sphere containing NO_2, the magnetism diminishes till the proportion of the two gases is sufficient to form hyponitric acid, NO_4, when the magnetic action becomes insensible. On adding more oxygen the magnetism reappears.

(4.) Hyponitric acid, NO_4, when condensed into a liquid is diamagnetic.

(5.) The magnetism of oxygen, deutoxyd of nitrogen and magnetic mixtures is proportional to the density of the gas.

(6.) A magnetic gas mechanically mixed with any other indifferent gas preserves its magnetism whatever be the density of the mixture, only in the neighborhood of the poles there appears to be to a certain extent a separation of the gases which must slightly augment the attraction of the entire mass.

(7.) A magnetic gas which has been for some moments attracted by an electro-magnet is very readily repelled if the polarity of the magnet be changed. Hence it appears that gases possess a very distinct coercive force.—*Comptes Rendus*, xxxiii, 301; *Pogg. Ann.*, lxxxiii, 87.

2. *Artificial formation of Minerals.*—Ebelmen has published a second memoir upon this subject containing many valuable additions to our knowledge, and throwing great light upon chemical geology and mineralogy. The method pursued in these investigations was the same as that employed by the author in his previous researches and consisted in dissolving the constituents of the mineral to be formed in an appropriate solvent and submitting the whole to evaporation at a high temperature in a porcelain furnace. Boric acid was the solvent commonly employed, but the author also used borax, phosphoric acid and certain alkaline phosphates. Of the minerals belonging to the spinelle group several were obtained by the author in his previous memoir;

the experiments however have been repeated and with better success as regards the size and perfection of the crystals obtained.

Magnesian spinelle Al_2O_3, MgO was prepared by igniting a mixture of alumina, magnesia, chromate of potash and boric acid, the mixture remaining in the furnace eight consecutive days. The crystals thus produced were octahedrons truncated upon the twelve edges; some of them three or four millimeters in the side: they were transparent, of great lustre and of a more less marked rose color. The angles measured perfectly corresponded to the theory: the density of the crystals was 3·542. Gahnite, Al_2O_3, ZnO, was obtained by a precisely similar process in well defined colorless octahedral crystals of density 4·58. By adding a small quantity of bichromate of potash to the mixture, ruby-red truncated octahedrons were obtained of great beauty and lustre. The author points out the fact that the atomic volumes of the two last mentioned compounds correspond almost perfectly, that of the former being 25·2, that of the latter 25·1. Chromite of manganese, Cr_2O_3, MnO, was obtained by igniting together oxyd of chromium, oxyd of manganese and boric acid. The crystals were regular octahedrons of a semi-metallic iron gray color, of density 4·87, and of a hardness sufficient to scratch quartz. Chromite of zinc, Cr_2O_3, ZnO, was procured in the same manner and obtained in the form of small, very brilliant regular octahedrons of a greenish black color, and of density 5·309 at 11 C. The atomic volumes of the chromites were found somewhat higher than those of the aluminites, that of chromite of zinc being 27·5, of chromite of magnesia 27·3, of chromite of manganese 28·7, of chromite of iron 28·3. Ferrite of zinc was obtained in the form of small black brilliant octahedrons, of density 5·132. Its atomic volume is 29·3.

The formation and properties of the artificial cymophane were described by the author in his first memoir. By repeating the experiment with the addition of carbonate of lime to the mixture of alumina, glucina and boric acid, a perfectly pure cymophane was obtained in transparent crystals 5 or 6 millimeters in length. These crystals have a slightly greenish tint, are hard enough to scratch topaz, and of density 2·759 at 12 C. The crystalline form was found to correspond perfectly with the determinations of Descloizeaux made with the natural mineral; many of the crystals were similar to those found at Haddam, in Brazil and the Ural. The author next describes two new compounds under the names of magnesia-borate of oxyd of chromium, and magnesia-borate of oxyd of iron. The empirical formulas of these compounds are $3Cr_2O_3+2BO_3+6MgO$, and $3Fe_2O_3+3BO_3+6MgO$; the author proposes the rational formulas $3Cr_2O_3+2(BO_3, 3MgO)$ and $3Fe_2O_3+2(BO_3, 3MgO)$. A tribasic borate of magnesia BO_3, 3MgO was obtained by fusing magnesia with an excess of boric acid at a high temperature. The compound forms radiating crystals of a nacreous aspect and very high lustre; its density is 2·987; it is insoluble in water but easily soluble in acids. Peridot, SiO_3, 3MgO, was obtained by fusing together silica, magnesia and boric acid; the crystals were several millimeters in length, perfectly transparent but slightly yellow; their form was an octahedron with a rectangular base deeply truncated upon its two summits. The angles measured agreed

perfectly with those of the mineral species. The author points out the interesting fact that the atomic volumes of this compound and the corresponding borate already described are almost identical, viz., 133·8 for the silicate, and 132·3 for the borate. A second silicate of magnesia, $2SiO_3$, $3MgO$, was formed in the same manner and exhibited crystals having the form and angles of diopside. Two corresponding silicates of zinc were also obtained in indistinct crystals. A borate of alumina having the formula $(Al_2O_3)^2\ BO_3$ was prepared by igniting alumina with borax or by igniting alumina, oxyd of cadmium and boric acid. The crystals were rectangular prisms from six to ten millimeters in length, transparent and colorless and hard enough to scratch quartz. The addition of silica to the mixture prevented the formation of a borate and the alumina then crystallized in large hexagonal crystals of a very high lustre. These crystals are double six-sided pyramids deeply truncated upon their two summits; the measured angles exactly corresponded with those of corundum. The density of the crystals was found to be 3·928 at 20 C.; their hardness was that of corundum and they easily scratched topaz. In this process the silica may be replaced by other substances; carbonate of baryta gave large crystals of the same form; carbonate of soda produced the same effect, and several other bodies were employed without essentially modifying the result. Rutile was obtained in long acicular prisms by igniting a mixture of titanic acid with the phosphate of soda and ammonia; the crystals were transparent and of a golden yellow color; their density was 4·283, which agrees with that of rutile. It will be remembered that Daubrée obtained titanic acid crystallized by the action of the vapor of water upon the chlorid of titanium at a high temperature; the crystals were however identical with Brookite. Niobic and tantalic acids fused with an excess of salt of phosphorus yielded long greenish transparent prisms. The author proposes to examine these acids more completely hereafter.—*Annales de Chimie et de Physique*, xxxiii, 34, *Sept.*, 1851.

3. *Preparation of Tungstate of Soda and Tungsten.*—Wright has discovered a very simple method of preparing this remarkable compound which has attracted much attention from its resemblance to metallic gold. Crystallized dried bitungstate of soda is to be fused in a porcelain crucible over a spirit lamp and to the fused mass metallic tin is to be added in single small fragments. The formation of the crystals instantly commences at the surface of the melting tin and these soon fill the whole mass; the heat should not be greater than is requisite to fuse the bitungstate and the process should last but a very short time if it be desired to obtain large and fine crystals. It is very remarkable that the cubes of the tungstate of soda and tungsten are absolutely infusible at the temperature at which the process is carried on and that the largest crystals do not even appear to be formed in immediate contact with the tin. When the mass has cooled, the gold colored cubes are to be isolated by digesting them alternately with concentrated caustic potash and chlorohydric acid, and then well washed with water and dried. The density of the crystals was found to be 6·617, they are perfect conductors for the electric current; analysis gave 93·8 per cent. of tungstic acid which corresponds to Wöhler's formula, WO_2, $WO_3+NaOWO_3$.—*Ann der Chemie und Pharmacie*, lxxix, 221.

4. *Phosphuret of Tungsten.*—Wöhler has described a remarkable compound of tungsten with phosphorus, prepared and analyzed in his laboratory by Wright. Impure phosphoric acid containing lime is to be mixed in coarse powder with tungstic acid, in the proportion of 9 of phosphoric to 2 of tungstic acid, and the mixture is to be ignited in a charcoal crucible for an hour, at a temperature at which metallic nickel becomes perfectly fused. On cooling, the crucible is found to contain a hollow mass of gray phosphuret of tungsten, lined upon the inside with the most brilliant crystals. These crystals have a dark steel color, with a remarkably brilliant metallic lustre; they are six-sided prisms, apparently of the same form as gypsum; their density is 5·207; they are perfect conductors of the electric current. In contact with zinc in dilute acid they evolve hydrogen, and in a solution of a salt of copper they become covered with metallic copper. The phosphuret is unchanged at the temperature in which manganese fuses; heated to redness in the air it undergoes scarcely any change; heated upon charcoal in a current of oxygen, it burns with great brilliancy, yielding a deep blue sublimate upon the coal. In the same manner it burns with fused chlorate of potash; acids exert no action upon it. Wright found the constitution of this compound to correspond with the formula PW_4. —*Ann. der Chemie und Pharmacie*, lxxix, 244.

5. *Telluret of Ethyl.*—Mallet has discovered the remarkable fact that the telluret of ethyl enters into combination, like an organic radical, uniting directly with oxygen, sulphur, &c. Telluret (tellurid) of ethyl heated with warm nitric acid, is dissolved with evolution of nitric oxyd. If the solution be evaporated to dryness, a white crystalline mass remains, which is soluble in water, and when heated, burns like gunpowder. Mallet infers from its general relations that its constitution is $C_4H_5TeO+NO_5$. Sulphuretted hydrogen produces in a solution of this salt an orange colored easily fusible precipitate, probably C_4H_5TeS. When chlorohydric acid is added to a solution of tellurid of ethyl in nitric acid, a colorless, heavy oil is separated, which possesses an offensive odor and may be distilled without change, though at a very high temperature; Mallet found its constitution expressed by the formula C_4H_5TeCl. Treated with oxyd of silver, the chlorid of the new radical yields chlorid of silver, and the oxyd of tellurethyl, C_4H_5TeO remains in solution and may be obtained by evaporation, as a colorless, highly crystalline mass. The new oxyd in solution has an alkaline reaction; heated in a tube, it is decomposed with separation of metallic tellurium and an offensive oil. In the air the oxyd burns with a blue flame; sulphurous acid separates tellurid of ethyl; chlorohydric acid precipitates the chlorid in colorless drops. With chlorid of platinum the oxyd of tellurethyl gives a yellow, with chlorid of mercury, a white precipitate; with chlorid of ammonium, a salt is obtained having the formula $C_4H_5TeCl+2NH_4Cl$, and crystallizing in the form and with the angles of gypsum.—*Ann. der Chemie und Pharmacie*, lxxix, 223.

6. *On white Precipitate.*—Wagner has found that white precipitate is readily acted upon by amyl-mercaptan, the products of the action being sulphid of mercury and chlorid of amyl-ammonium; the reaction is represented by the equation $NH_2Hg_2Cl+C_{10}H_{12}S_2=2HgS$

$+NH_3(C_{10}H_{11})Cl$. Wagner suggests that triethylamin may be formed by the action of sulphid of ethyl upon the nitruret of mercury, NHg_3, and that decompositions of a similar character promise to throw much light upon the constitution of ammonia and amid compounds.—*Journal für praktische Chemie*, liii, 378.

7. *Quantitative separation and determination of Phosphoric Acid.*—Reynoso has proposed a method of separating phosphoric acid quantitatively, based upon the fact that phosphate of peroxyd of tin is insoluble in nitric acid, while other phosphates are soluble. A weighed portion of pure tin is to be introduced into a balloon with the phosphate, nitric acid added in excess, and the whole boiled. When the whole of the tin has been oxydized the mass is to be thrown upon a filter, washed, dried, heated to redness over a spirit lamp, and weighed. The difference between this weight and the weight of peroxyd of tin yielded by the tin employed, gives the weight of the phosphoric acid. The filter must be carefully burned, a few drops of nitric acid being added to prevent reduction. The flame of the lamp must also be carefully managed so as not to mount too high, and finally the mass must be rapidly weighed, as it is very hygroscopic. The process gave good results when applied to the analysis of pyrophosphate of soda, the only compound which Reynoso appears to have examined.—*Comptes Rendus*, xxxiii, 385.

8. *Propylamine in Plants.*—Dessaignes has discovered propylamine in Chenopodium vulvaria. Forty kilogrammes of the plant were distilled with a solution of carbonate of soda. The distillate was saturated with chlorohydric acid, evaporated to dryness, and treated with strong alcohol, which left a large quantity of salammoniac undissolved. The alcoholic solution was precipitated by bichlorid of platinum; the precipitate by recrystallization gave large reddish orange crystals, which were found to have the formula NC_6H_9, $HCl+PtCl_2$.—*Comptes Rendus*, xxxiii, 358.

9. *Sulphid of Nitrogen.*—Fordos and Gélis have published an elaborate investigation of the sulphid of nitrogen obtained by the action of ammonia upon perchlorid of sulphur, and concerning the constitution of which there has been much doubt hitherto. The authors prepare the substance in question by passing ammonia into a solution of perchlorid of sulphur in eight or ten times its volume of bisulphid of carbon. In this process sal-ammoniac is first deposited; then a cochenille-red compound, partly soluble in the liquid, but soon disappearing to give place to a brown matter which in its turn disappears. When this happens the process is finished. The liquid is now to be filtered and allowed to evaporate spontaneously, when the sulphid of nitrogen crystallizes. The mother liquor contains sulphur; the mass on the filter is a mixture of sal-ammoniac and sulphid of nitrogen, which may be separated by treatment with boiling bisulphid of carbon. Sulphid of nitrogen as thus prepared, presents transparent crystals of a beautiful golden yellow: the crystals, according to Nicklès, belong to the right rhombic system. The powder of the sulphid of nitrogen has a brilliant yellow color; when rubbed or struck with a hard body it explodes with great violence; brought into contact with an ignited body it fuses without explosion; heated in an oil bath to 157° C., the sulphid explodes, yielding nitrogen

and the vapor of sulphur. Sulphid of nitrogen has little or no odor, but it strongly irritates the mucus membranes when brought into contact with them. In water it is insoluble; alcohol, ether and turpentine dissolve small portions of it; bisulphid of carbon is its best solvent. The composition of the sulphid of nitrogen was found to be expressed by the formula NS_2. Boiling water decomposes the bisulphid of nitrogen; the reaction is expressed by the equation

$$4NS_2+15HO=S_2O_2,\ NH_4O+2(S_3O_5,\ NH_4O)+NH_3.$$

Caustic potash in like manner produces decomposition; the final products of the action are expressed by the equation

$$2NS_2+3KO+6HO=S_2O_2,\ KO+2SO_2KO+2NH_3.$$

The bisulphid of nitrogen unites directly with the two chlorids of sulphur and forms with each several distinct compounds. The authors assign to three of these combinations the formulas $ClS+NS_2$, $ClS+2NS_2$, $ClS+3NS_2$.—*Ann. de Chemie et de Physique*, xxxii, 389.

10. *On a class of ammoniacal compounds of Cobalt.*—CLAUDET has described a new base containing cobalt and the elements of ammonia. Ammonia is to be added in excess to a solution of proto-chlorid of cobalt mixed with four times its weight of chlorid of ammonium. The solution rapidly absorbs oxygen from the air, and if placed in a bottle so as to fill it about half and repeatedly agitated, removing the stopper from time to time to renew the air, the absorption is complete in a few days and the liquid changes from dark brown to an intense violet red. By boiling the solution strongly acidulated with chlorohydric acid, a heavy crimson powder is deposited. When cold, the liquid is decanted and the precipitate washed by decantation, thrown on a filter and dried. To obtain it crystallized, it may be dissolved in boiling water, to which a few drops of chlorohydric acid have been added; on cooling, the salt is deposited in the form of small sparkling ruby-red octahedrons. The new salt is sparingly soluble in cold water, more soluble but slightly decomposed in boiling water; the decomposition may however be prevented by adding a few drops of chlorohydric acid. Chlorohydric acid and the chlorids of ammonium and sodium completely precipitate the salt from its solutions: sulphuric and nitric acids partially transform it into sulphates and nitrates; potash and soda decompose the solution, evolve ammonia and throw down a hydrated peroxyd of cobalt. Sulphuretted hydrogen precipitates the whole of the cobalt as a bisulphid. The analyses of the new salt led to the formula $Co_2Cl_3N_5H_{16}$, so that its formation may be represented by the equation $2CoCl+NH_4Cl+4NH_3=Co_2Cl_3N_5H_{16}$. These elements may obviously be grouped in various ways; perhaps the most probable is the following: $ClN\left\{\begin{matrix}H^2\\Co^2\end{matrix}\right.+2ClN\left\{\begin{matrix}H_3\\NH_4\end{matrix}\right.$, admitting with Graham that NH_4 may replace hydrogen. With chlorid of platinum the salt yields a buff-colored silky precipitate, $Co_2Cl_3N_5H_{16}+2PtCl_2$. With chlorid of mercury it gives a bulky silky precipitate of red needles represented by $Co_2Cl_3N_5H_{16}+6HgCl$. Oxyd of silver throws down the chlorine from the salt and yields a highly alkaline liquid, which on standing a few hours is decomposed; the solution contains the oxyd of the new base $Co_2O_3N_5H_{16}$. The author has obtained

several salts of this oxyd which are not described. The chlorid $Co_2Cl_3N_3H_{16}$, when ignited in a current of hydrogen, yields pure metallic cobalt; ignited per se, it yields the protochlorid mixed with a little oxyd, from which it is easily separated by solution and filtration. Claudet recommends the preparation of this salt as a means of obtaining chemically pure cobalt compounds direct from the ores. The discovery of this class of cobalt compounds is due to Dr. Genth; it is understood that Frémy is engaged in a complete investigation of them. —*L. and E. Phil. Mag., Oct.*, 1851. W. G.

II. Mineralogy and Geology.

1. *Mineralogical Notices;* by W. P. Blake.—*Chlorite.*—Having received fine cleavage specimens of the Achmatowsk chlorite,* I have examined them by polarized light and find indications of a uniaxial character; the symmetrical cross was clearly visible in all the plates subjected to examination. This confirms the observations of those who have examined the chlorites, and proves them to be rhombohedral or hexagonal in crystallization. There can no longer be any doubt of the anomalous optical character of the Chester Co. (Pa.) mineral, which I have named *Clinochlore.*†

Red Sapphire.—I have discovered a new locality of this mineral, in the township of Vernon, Sussex Co., N. J., where it occurs in the well known white crystalline limestone of that region, and with the associated minerals it appears to constitute a true vein of segregation. As the minerals have been but recently removed, there has not been time to bestow on many of them the examination they require, and therefore a brief notice only can be given at this time. The sapphire is remarkable for its irregular "ragged" form, which is best seen in those crystals, which were obtained from the soil where atmospheric agencies had removed the calcareous investment, and left the sapphire with its thin and ragged excrescences entire. The color of the finest specimens is "ruby red," others have various shades of purple:—they are translucent, no *transparent* specimens having been obtained.

The associated minerals are remarkable for their beauty and peculiarity; the following list embraces those which occur in greatest abundance: Red spinel, rose spinel, chondrodite, hornblende, iron pyrites, phlogopite, graphite, hydrous sesquioxyd of iron, hydrous silicates of alumina. The following minerals occur sparingly: Rutile, sphene, ilmenite, zircon, blue fluor, and emerylite.

Argentiferous galena.—Mr. C. M. Wheatley has recently opened rich veins of this ore near Phœnixville, Chester Co., Pa. With the galena the following minerals have been observed: *Sulphate of lead*, in large crystals; *Carbonate of lead*, in splendid crystallizations; *Phosphate of lead*, of a fine green color in good crystals; *Chromate of lead*, in small crystals associated with pyromorphite and cerasite, usually implanted upon the dark green pyromorphite, forming beautiful cabinet specimens.

* Received from Prof. J. D. Dana, who had them from Joseph A. Clay, Esq., of Philadelphia.

† This Journ., xii, p. 339, 1851.

Chalcotrichite.—This beautiful mineral was found by Mr. C. M. Wheatley, filling small cavities in the sulphuret of copper from the Perkiomen copper mine. It was formerly obtained from the Perkiomen lead mine.

Sulphuret of Nickel.—Sulphuret of nickel occurs in Lancaster Co., Pa., associated with massive chrome iron, emerald nickel, and a massive "violet talc," in which it is imbedded in small grains and nodules.

Lievrite.—Lievrite has been found in Monroe, Orange Co., N. Y., at the O'Neil iron mine, in long blade-like crystals, upon crystals of magnetite.

2. *On the Angles of Eumanite;* by J. E. TESCHEMACHER, (from a letter to one of the editors, dated Boston, Nov. 11th.)—By careful management I have obtained the following measurements of my crystals of eumanite, by *usual* reflection with my goniometer.*

$\breve{e}$ on $\breve{e}'$, 108° } on the smaller crystal.
$\breve{e}'$ " e', 140° 15' }
e' " e'', 159° 30' } on the larger crystal.
$\breve{e}$ " *o*, 128° 15' }

3. *On the Silurian System of Central Bohemia;* by M. BARRANDE, (Bull. Soc. Geol. de France, viii, [2], 150, Jan., 1851.)—M. Barrande, in his observations on the Silurian System of Central Bohemia, recognizes an upper and a lower Silurian corresponding to what has been made out, first in England and since in Russia and America. Each of these divisions contains four subdivisions or groups, which he letters A, B, C, D, and E, F, G, H. The lower Silurian consists almost wholly of siliceous and argillaceous rocks, to the nearly total exclusion of limestones; the upper consists mainly of limestones. The limit between the two is marked by eruptions of trap of great extent, which alternate with graptolite schists, in which twenty species of graptolites have been detected. Trilobites analogous to those of the Caradoc sandstones and Llandeilo flags, (corresponding to subdivision D) abound in the lower division, while in the upper, great numbers of Cephalopods, Gasteropods, Brachiopods and Acephala occur, families hardly represented in the lower Silurian of Bohemia.

The groups A and B are without fossils, or *azoic*, and have together a thickness of 24 to 26,000 feet. A is composed of semi-crystallized and argillaceous schists, and B to a great extent of conglomerates alternating with argillaceous schists; they pass almost insensibly into one another. C consists mainly of greenish argillaceous schists, and is not over 1300 feet thick. Its fossils are mostly trilobites, and they are peculiar in having the thorax very much developed, with the pygidium very small; the principal genera are *Paradoxides*, *Elliptocephalus*, *Conocephalites*, &c. The group D, called also the *quartzite* division, abounds in siliceous as well as argillaceous rocks, and is very rich in trilobites. Its vertical extent is 8 to 10,000 feet.

The several subdivisions from C upward are each distinct in their fossils. Not a species of C occurs in D, and even the genera of trilobites are mostly distinct. The extinction of the fossil species of C, is referred to ejections of porphyry and other igneous rocks.

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* For figure, see last volume of this Journal, page 397.

M. Barrande points out the existence of what he calls *colonies* of the upper Silurian interpolated in the D group of the lower Silurian. They are beds sometimes 100 yards thick, having the upper Silurian character in the fossils. M. Constant Prevost observed, on the conclusion of M. Barrande's remarks, that if the existence of such *colonies* can be admitted as proved, (which must require still more investigation,) it indicates a synchronism between two different marine formations, and shows that extended systems of cotemporaneous beds may be palæontologically distinct, while at the same time, beds of successive ages may be identical in their fossils.

M. Barrande stated it as his belief, that the granites which surround the Bohemian Silurian basin are subsequent in age to the schistose formations.

4. *Examination and Analysis of the Ball Coal of the Burdwan Mines;* by HENRY PIDDINGTON, Curator Museum Economic Geology.—The Museum is indebted for this specimen to D. Williams, Esq. the Government Geologist, who informs me that these balls are very common among the Burdwan mines, though I am not aware that they have ever been noticed before. He says they are of all sizes, from that of a cannon ball, to a man's head, and even 18 inches in diameter.

Like the Burdwan, and many English kinds of coal, these balls are composed of alternate layers of a bright bituminous and a dull jetty kind of coal, splitting easily between the layers. Our specimen was very tough and difficult to cut with a saw. There was no difference between the center and the periphery of the ball, nor anything that could give the idea of a nucleus or of concentric layers.

And upon considering it attentively it will be seen at once that it is nothing more than an oblique rhomboidal prism of the common coal of the mines, rounded *somehow* into a rough ball. So far, for the present as to its external characters.

I find its specific gravity to be 1·37. The mean of 5 specimens of Burdwan Coal, according to Mr. Prinsep, is 1·365. I place here its analysis and the mean of the first six specimens in Mr. Prinsep's table.

	Analysis of the Ball coal.	Mean of Burdwan coal. Mr. Prinseps's table.
Water,	5·00	7·4
Volatile matter,	29·00	35·6
Carbon,	57·00	52·5
Ash,	9·00	12·2
	100·00	

There was a slight excess in my analysis; no doubt due to the peroxydation of the iron.

5. *Gold in Australia.*—The gold region of New South Wales, situated in the mountain south of west from Sydney, in the Bathurst District, appears from the reports still to promise well. From Sydney papers we learn that the existence of gold was first predicted by Rev. W. B. Clarke, who has long been engaged in investigating the geology of the country. His opinion was based upon his knowledge of the character and position of the rocks, and he early recommended exploration in

the main Australian range along the meridian of 149°, where gold has been found. Rev. Mr. Clarke states the singular fact that just 90° west of the auriferous range in Australia, we find an auriferous band in the Urals; and just 90° west of the Urals occur the auriferous mountains of California.

III. Zoology.

1. *On the Classification of the Crustacea Corystoidea;* by James D. Dana.—The Corystoidea have their closest relations with the Cancroidea, and form a passage between this division of the Brachyura and the Hippidea. They are remote from the Oxystomata in the mouth and efferent branchial channels, the latter having these channels *medial* over the palate, and the former *lateral* like the Cancroids. In the projection of the outer maxillipeds over the epistome, the elongated and more or less pilose outer antennæ, and the partially free or less closely inflexed abdomen, the species exhibit their degradation below the Cancer type. The Platyonychidæ are the Cancroids which approximate most to the Corystoids, and they are placed with this group by De Haan. But they differ from the Corystoidea in the shorter and more naked outer antennæ; and we therefore incline rather to retain them with the Crancroidea, where they are arranged by Milne Edwards.

The degradation of the Cancroidea is also seen in another line leading through *Acanthocyclus* to *Corystoides*, Lucas, and *Bellia*, Edw.* The last two genera are somewhat Corystoid in habit: yet they pertain to a distinct group, inasmuch as they have the outer antennæ obsolete or nearly so, and the inner antennæ *without fo[illegible]tes.* This last character belongs only to the lower Anomoura and the Macroura, and places these genera quite low in rank in a group we name Bellidea which belongs near if not among the Anomoura.

In attempting to arrange the Corystoidea into groups, we consider, as in other cases, the relations of the species to the higher Crustacea, and by the transitions observed, we are led to our subdivisions. *Trichocera* is Cancroid in habit, in the absence of a beak, in the nearly naked outer antennæ, and in having the outer maxillipeds fitted neatly to the epistome. *Thia* and *Kraussia* are also without a beak, like the Cancroids, but have the outer maxillipeds overlapping the epistome. The remaining genera have the front somewhat rostrate, the inner antennæ longitudinal, the maxillipeds produced over the epistome and the outer antennæ elongate and pilose and flexed at base towards the medial line. The form of the third joint of the outer maxillipeds varies from narrow oblong to transverse in closely related genera, and affords no basis for a family distinction.

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* In the synopsis of the Cancroidea in this Jour., vol. xii, p. 131, Corystoides was placed near Acanthocyclus, to which it has close relations; but from this and the other Cancroids, it is removed by the absence of all power of retraction in the inner antennæ.

The name *Bellia* has been recently duplicated in the science, in an article by Mr. C. Spence Bate, on a new genus of Amphipods near Lepidactylis, published in the Annals and Mag. Nat. Hist., [2], vii, 318, pl. 11, f. 8, 1851. The description of Milne Edwards's genus of this name is published in the Ann. des Sci. Nat. [3], ix, 1848, p. 192.

The following are the families thus deduced, with the genera of Corystoidea and their characteristics.

Fam. I. TRICHOCERIDÆ.

Carapax formâ Cancroideus, fronte non rostratus. Antennæ internæ longitudinales. Antennæ externæ breves, flagello parce piloso. Maxillipedes externi super epistoma non producti, sed margini areæ buccalis bene adaptati.

Gen. Trichocera, *DeHaan.**—Frons dentatus. Articulus maxillipedis externi 3tius apice truncatus. Articulus antennarum externarum 1mus elongatus, hiatum orbitæ bene occupans.

Fam. II. THIIDÆ.

Carapax suborbicularis, non oblongus, fronte non rostratus. Antennæ internæ transversæ vel obliquæ. Antennæ externæ breves, flagello parce piloso. Maxillipedes externi super epistoma producti.

Gen. 1. Thia, *Leach.*—Frons integer, arcuatus. Antennæ internæ transversæ. Pedes nulli natatorii. Articulus maxillipedis externi 3tius vix oblongus.

Gen. 2. Kraussia, *Dana.*† Carapax paulo transversus, margine postero-laterali brevi, fronte denticulato, medio emarginato. Antennæ internæ obliquæ. Pedes 8 postici natatorii, tarso falciformi. Articulus maxillipedis externi 3tius vix oblongus.

Fam. III. CORYSTIDÆ.

Carapax sive suborbicularis sive multum angustus, fronte plus minusve rostrato. Maxillipedes externi super epistoma producti.

1. *Pedes nulli natatorii.*

G. 1. Telmessus, *White.*‡—Carapax parce transversus, pone medium latior, fronte paulo producto et medio emarginato. Articulus antennarum externarum 1mus elongatus, processu elongato hiatum orbitæ bene occupans. Articulus maxillipedis externi 3tius parce oblongus apice triangulatus, articulum 4tum prope apicem gerens.

G. 2. Atelecyclus, *Leach.*§—Carapax fere orbicularis, lateraliter arcuatus, fronte paulo producto. Articulus antennarum exter-

* Faun. Japon. (1833), p. 16.

† Ad species complectendum *Xantho integrum* DeHaanii, (Faun. Japon. 66, tab. 18, f. 6) et *Platyonychum rugulosum* Kraussii ("Südaf. Crust." 26, tab. 1, f. 5), Thiæ affines et Xantho remotas, genus "Kraussia" institutum est. Platyonycho discrepat margine postero-laterali breviore quam antero-lateralis, carapace paulo transverso, fronte bilobato et denticulato, flagello antennarum internarum subpiloso. An *Trichocera porcellana* (A. White, "Voy. Samarang," p. 59) a Kraussii specie differt?

‡ A. White, "Ann. Mag. Nat. Hist.," xvii, 497, 1846; Voy. Samarang, 14, tab. 3. *Atelecyclo*, habitu, antennis aliisque, Kraussia affinis: ejus affinitas Maioideis, ab Adamsio White edita, justa non videtur.

§ *Chlorodius* DeHaanii, Faun. Japon., 13.

narum 1mus elongatus hiatum bene occupans. Articulus maxillipedis externi 3tius oblongus, apice oblique truncatus, in marginis interni emarginatione articulum 4tum gerens.

G. 3. PELTARION, *Hombron et Jacquinot.**—Carapax suborbicularis, ante medium latior, fronte triangulatè rostrato. Articulus antennæ externæ 1mus perbrevis, 2do parce crassior. Articulus maxillipedis externi 3tius non oblongus, apice truncatus. Articulus pedum 8 posticorum 5tus 4to vix brevior.

G. 4. PSEUDOCORYSTES, *Edwards.*—Carapax suborbicularis, parce oblongus, triangulatè rostratus. Articulus maxillipedis externi 3tius vix oblongus. Articulus pedum 8 posticorum 5tus 4to duplo brevior.

G. 5. GOMEZA, *Gray.*†—Carapax oblongus, fere ellipticus, triangulatè rostratus. Oculi parvi vel mediocres. Articulus maxillipedis externi 3tius vix oblongus vel transversus, apice truncatus. Articuli pedum 8 posticorum 5tus et 4tus fere æqui.

G. 6. OEIDIA, *DeHaan* (partim).‡—Carapax oblongus, antice non angustans, fronte breviter rostrato. Oculi permagni. Articulus maxillipedis externi 3tius latus, oblongus, 2ndo paulo brevior. Articuli pedum 8 posticorum 5tus et 4tus fere æqui.

G. 7. CORYSTES, *Latreille.*—Carapax oblongus, rostratus. Oculi mediocres. Articulus maxillipedis externi 3tius angustè oblongus 2do vix brevior.

2. *Pedes postici natatorii.*

G. 8. DICERA, *DeHaan.*§—Carapax oblongus, rostro late triangulato. Pedes postici natatorii, tarso falciformi. Articulus maxillipedis externi 3tius angustè oblongus, 2do parce brevior.

2. *Conspectus Crustaceorum, &c.—Conspectus of the Crustacea of the Exploring Expedition under Capt. Wilkes, U.S.N.;* by JAMES D. DANA. —PAGURIDEA, (Proc. Acad. Nat. Sci., Philad., 1851. p. 267.)—This paper contains a distribution of the Paguridea into genera, and also a description of new species. The natural groups have been partly indicated by Milne Edwards in his work on Crustacea, and more lately in the Annales des Sciences Naturelles for 1848, p. 59. There are, however, in his arrangement, discrepancies between the characters of the species and those laid down for his subdivisions which we find it difficult to explain. Such are, the placing of *Pagurus tibicen* and some related species with his "*Æquimanes*," when the left hand is very much the larger, and the *guttatus* and *granulatus* with the "*Senestres*," although the hands are nearly equal in the former, and the right is the larger in the latter. Still his sections are in the main natural groups, and some of them have more important points of distinction than this distinguished author has mentioned.

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* *Hombron et Jacquinot*, "Voy. au pole Sud," tab. 8, f. 1.

† *Oeidia* DeHaanii (partim), Faun. Japon. 15. Species Oeidiæ typica (*O.* 20-*spinosa* denominata) *Gomeza* vera est.

‡ Faun. Japon. 15. Species *Oeidia distincta* DeHaanii, typus est generis Oeidiæ accepti. Genus idem est *Jonas*, (Hombron et Jacquinot, "Voy. au pole Sud," tab. 8, f. 4–8.) Species *J. macrophthalmus*, oculis grandibus formâ characteribusque aliis, *Oeidiæ distinctæ* ferme similis.

§ Faun. Japon. 14, (1833). *Nautilocorystes*, Edwardsii, Crust. ii, 149 (1837).

The *Pagurus Bernhardus* is the type of one group the species of which live mostly in the colder oceans. This genus is called BERNHARDUS, and the common species naturally bears Leach's specific name, *Bernhardus streblonyx*. The 2d genus is called DIOGENES; *Pagurus miles* is the type. The 3d, PAGURISTES, having for its type, *Pagurus gonagrus* or *P. pilosus*. The preceding have the fingers acuminated, while in the following genera they are spoon-excavate at tip. The 4th genus is PAGURUS, a large group including *P. punctulatus*, having corneous tips to the fingers, and no beak; the 5th, CALCINUS, with *P. tibicen* as the type, with calcareous tips and a short beak; [6th, ANICULUS, equal handed and beaked, and with corneous tips to the fingers like the following, but having a vertical movement in the fingers, as in *Pag. aniculus*;* 7th, CLIBANARIUS, equal-handed and having a lateral or horizontal movement in the fingers, as in *Pagurus clibanarius*. The last two genera are here for the first time published, not being included in the paper in the Academy's Proceedings.—D.]

The following is a synopsis of the genera:

FAM. I. PAGURIDÆ.

Antennæ internæ mediocres, articulo 1mo brevissimo. Maxillipedis externi palpus flagello multiarticulato instructus.—Species aquaticæ vel littorinæ.

1. PAGURINÆ.—Abdomen asymmetricum.

1. *Digiti acuminati. Flagellum antennarum internarum sæpe plus minusve pilosum.*

Gen. 1. PAGURISTES, (*D.*)—Pedes 4ti non subcheliformes, tarso terminali. 2–4 appendicibus pone pedum posticorum bases instructus. Basis antennarum internarum paulo longior, apice articuli 2di extremitatem oculorum fere attingente.

Gen. 2. DIOGENES, (*D.*)—Pedes 4ti subcheliformes. Pedes 1mi inæqui, sinister major. Annulum ophthalmicum rostriferum. Appendicibus pone pedum posticorum bases carens.

Gen. 3. BERNHARDUS, (*D.*)—Pedes 4ti subcheliformes. Pedes 1mi interdum subæquales, sæpius dexter major. Annulum ophthalmicum non rostriferum. Appendicibus articulatis pone pedum posticorum bases carens.

2. *Digiti instar cochlearis excavati. Flagellum antennarum internarum nudum vel nudiusculum.*

Gen. 4. PAGURUS.—Manus anticæ sæpius compressæ, interdum subæquæ, sæpius sinistrâ majore; digitis apice corneis, in plano verticali claudentibus. Frons medio non rostratus sed truncatus.

Gen. 5. CALCINUS, *D.*—Manus anticæ compressæ, inæquæ, sinistrâ majore, digitis apice calcareis, in plano verticali claudentibus. Frons medio breviter rostratus.

Gen. 6. ANICULUS, *D.*—Manus anticæ subæquæ, digitis apice corneis, in plano verticali claudentibus. Frons medio breviter rostratus.

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* The Pagurus aniculus may hereafter be named *Aniculus typicus*.—D.

Gen. 7. CLIBANARIUS, *D.*—Manus anticæ plus minusve depressæ, subæquæ, digitis apice corneis, in plano horizontali claudentibus. Frons medio breviter rostratus.

II. CANCELLINÆ.—Abdomen symmetricum.

Gen. CANCELLUS, *Edwards.*

FAM. II. CENOBITIDÆ.

Antennæ internæ multo elongato, articulo 1mo oculis sæpius longiore, valde deflexo. Maxillipedis externi palpus flagello non instructus.—Species subterrestriales.

Gen. 1. CENOBITA, *Edw.*—Corpus angustum, carapace elongato, fronte non rostrato. Abdomen in cochleam retortum, superficie plerumque carnosum.

Gen. 2. BIRGUS, *Leach.*—Corpus latum, carapace parce oblongo postice latissimo, fronte triangulato. Abdomen directum, laminis crustaceis dorso plerumque tectum.

The following are the names of the species described in this paper: Bernhardus Novi-Zealandiæ, B. armatus, B. hirsutiusculus, B. pubescens, B. tenuimanus, Paguristes longirostris, P. hirtus; Pagurus fabimanus, P. scabrimanus; together with the following referred to Pagurus, but which pertain to the new division Clibanarius, C. æquabilis, C. zebra, C. humilis, C. globoso-manus. The last may be the P. corallinus of Edwards. Also Cenobita carnescens and C. brunnea. D.

3. *On the Genus Orthostoma;* by JAMES D. DANA.—The genus Orthostoma was referred by its describer, Dr. Randall, (J. Acad. Nat. Sci., Philad., viii, 121, pl. 5, 1840,) to the family Gecarcinidæ. In its convex or obese form, it approaches that group. Yet the dentate antero-lateral margin, and thin dentate front led to his remarking that "the species has at first sight much resemblance to the Cancers." Upon examining the specimens, recently, in the collections of the Academy at Philadelphia, I find that in their essential characters as well as the texture of the carapax, the species is related to the Telphusidæ. The male verges are situated as in Telphusa, and not as in the Grapsoidea; and in general habit, the described species is near Potamia and Trichodactylus. It has the 2d joint of the outer maxillipeds oblong (but little shorter than the second), with the summit oblique, and the 4th joint articulated with it near the outer apex. The male abdomen is very broad triangular, and 5-jointed.

The known genera of Telphusidæ, are, then, as follows:—

G. 1. TELPHUSA, *Latr.*—Articulus maxillipedis externi 3tius subquadratus, 2dus multo brevior, 4tum angulo apicali interno gerens.

G. 2. VALDIVIA, *White.*—Articulus maxillipedis externi 3tius oblongus, 2dus transversus. [Carapax margine antero-laterali 4-dentatus.] Pedes longi.

G. 3. POTAMIA, *Latr.*—Articulus maxillipedis externi 3tius subquadratus, apice subtriangulatus anguloque apicali 4tum gerens.

G. 4. Trichodactylus, *Latr.*—Carapax marginibus subinteger. Articulus maxillipedis externi 2dus oblongus, 3tius vix oblongus, subtriangulatus, margine terminali valde obliquo anguloque externo 4tum gerens, 2ndo multo brevior.

G. 5. Orthostoma, *Randall.*—Carapax margine antero-laterali dentatus. Articulus maxillipedis externi 2dus oblongus, 3tius oblongus, 2do paulo brevior, apice obliquus, prope angulum exteriorem articulum 4tum gerens.

4. *Genus Heterograpsus of Lucas.*—The genus Heterograpsus, described in the recent work on the Exploration of Algiers, and figured on plate 2 of Crustacea, f. 4, has the outer maxillipeds and most other characters of *Pseudograpsus*, Edw.,* but differs from that genus in having the sides nearly straight and convergent backward as in most Sesarmæ, instead of arcuate. In the species described, the *H. sexdentalus*, the antero-lateral margin is bi-emarginate. J. D. D.

5. *On Recent Researches into the Natural History of the British Seas;* by Prof. Edward Forbes, (Proc. Roy. Soc., Feb. 14, 1851, p. 17.)—The Natural History of the British Seas has for a long time been a favorite subject of investigation. Within the last fifteen years, however, fresh inquiries have been set on foot, and the details of their zoology and botany worked out to an extent beyond that to which the examination of any other marine province has been carried. Numerous and beautifully illustrated monographs, treating of their fishes, Cetacea, portions of the Articulata, the Mollusca, Radiata, Zoophytes, Sponges, and Algæ, have been published, either at private cost, or by patriotic publishers, or by the Ray Society, such as the scientific literature of no other country can show. As these have all been the results of fresh and original research, they present a mass of valuable data sufficient to form a secure basis for important generalizations.

From these materials, and from the results of the enquiries into the distribution of creatures in the depths of our seas, conducted by a committee of the British Association, a clear notion may be formed of the elements of which our submarine population is composed. Extensive tables, exhibiting the sublittoral distribution of marine invertebrata, from the South of England along the Western coasts of Great Britain to Zetland, mainly constructed from the joint observations of Professor E. Forbes and Mr. Mac Andrew, are now preparing for publication, as a first part of a general report from the committee referred to. The data embodied in these tables are the produce of researches conducted during the last eleven years, and registered systematically at the time of observation.

British marine animals and plants are distributed in depth (or bathymetrically) in a series of zones or regions which belt our shores from high-water mark down to the greatest depths explored. The uppermost of these is the tract between tidemarks; this is the Littoral Zone. Whatever be the extent of rise and fall of the tide, this zone, wherever the ground is hard or rocky, thus affording security for the growth of marine plants and animals, presents similar features, and can be subdivided into a series of corresponding sub-regions; through all

* See this Journal, xi, 278.

of which the common limpet (*Patella vulgata*) ranges, giving a character to the entire belt. Each of these sub-regions has its own characteristic animals and plants. Thus the highest is constantly characterized by the presence of the periwinkle *Littorina rudis*, (and on our western shores, *Littorina neritoides*,) along with the sea-weed *Fucus canaliculatus*. The second sub-region is marked by the sea-weed *Lichina* and the common mussel (*Mytilus edulis*). In common with the third sub-region it almost always presents rocks thickly encrusted with barnacles; so that where our shores are steep, a broad white band, entirely composed of these shell-fish, may be seen when the tide is out, marking the middle space so conspicuously as to be visible from a great distance. In the third sub-region the commonest form of wrack or kelp (*Fucus articulatus*) prevails, and the largest periwinkle (*Littorina littorea*) with the *Purpura capillus* are dominant and abundant. In the fourth and lowest sub-region the *Fucus* just mentioned gives way for another species, the *Fucus serratus;* and in like manner the shells are replaced by a fresh *Littorina* (*littoralis*) and peculiar *Trochi*.

Once below low-water mark the periwinkles become rare, or disappear, and the *Fuci* are replaced by the gigantic sea-weeds known popularly as tangles (species of *Laminaria*, *Alaria*, *&c.*) among which live myriads of peculiar forms of animals and lesser plants. The genus *Lacuna* among shell-fish is especially characteristic of this zone. In sandy places, the *Zostera* or grass-wrack replaces the *Laminaria*. The LAMINARIAN ZONE extends to a depth of about fifteen fathoms, but in its lowest part the greater sea-weeds are comparatively few, and usually the prevailing plant is the curious coral-like vegetable called Nullipore.

From 15 to 50 or more fathoms we find a zone prolific in peculiar forms of animal life, but from which conspicuous vegetables seem almost entirely banished. The majority of its inhabitants are predacious. Many of our larger fishes belong to this region, to which, on account of the plant-like zoophytes abounding in it, the name of CORALLINE ZONE has been applied. The majority of the rarer shell-fish of our seas have been procured from this region.

Below 50 fathoms is the REGION OF DEEP-SEA CORALS, so styled because hard and strong true corals of considerable dimensions are found in its depths. In the British seas it is to be looked for around the Zetlands and Hebrides, where many of our most curious animals, forms of zoophytes and echinoderms, have been drawn up from the abysses of the ocean. Its deepest recesses have not as yet been examined. Into this region we find that not a few species extend their range from the higher zones. When they do so they often change their aspect, especially so far as color is concerned, losing brightness of hue and becoming dull-colored or even colorless. In the lower zones it is the association of species rather than the presence of peculiar forms which gives them a distinctive character. All recent researches, when scientifically conducted, have confirmed this classification of provinces of depth. When we have an apparent exception, as in the case of the submarine ravine off the Mull of Galloway, dredged by Capt. Beechy and recorded by Mr. Thompson, in which, though it is 150 fathoms deep, the fauna is that of the coralline zone, we must seek for an ex-

planation of the anomaly by inquiring into the geological history of the area in question. In this particular instance there is every reason to believe that the ravine mentioned is of very late date compared with the epoch of diffusion of the British fauna.

When we trace the horizontal distribution of creatures in the British seas, we find that though our area must be mainly or almost entirely referred to one of the great European marine provinces, that to which the lecturer has given the name of CELTIC, yet there are subdivisions within itself marked out by the presence or absence of peculiar species. The marine fauna and flora of the Channel Isles present certain differences, not numerous but not the less important, from that of the south-western shores of England, which in its turn differs from that of the Irish sea, and it again from that of the Hebrides. The Cornish and Devon sea fauna and that of the Hebrides are marked by redundancies of species; that of the eastern coasts of England on the contrary by deficiencies. Along the whole of our western coasts, whether of Great Britain or Ireland, we find certain creatures prevailing, not present on our eastern shores. In the depths off the south coast of Ireland we find an assemblage of creatures which do not strictly belong to that province, but are identical with similar isolated assemblages on the west coast of Scotland. In the west of Ireland we find a district of shore distinguished from all other parts of our coast by the presence of a peculiar sea-urchin, to find the continuance of whose range we must cross the Atlantic to Spain. In such phenomena the lecturer sees evidences of conformation of land, of outlines of coast and connections of land with land under different climatal conditions than at present prevail within our area, for an explanation of which we must go back into the history of the geological past. If we do so, we can discover reasons for these anomalies, but not otherwise.

The dredging researches about to be published, go to show that among our sublittoral animals the northern element prevails over the southern, —a fact indicated by the number of peculiar northern species; at the same time the southern forms appear to be diffusing themselves northwards more rapidly than the northern do southwards. This diffusion is mainly maintained along our western shores, and appears to be in action, not only in the British seas, but also along the shores of Norway. We must attribute it to the influence of warm currents flowing northwards, originating probably in extensions of the gulf-stream. The body of colder water in the depths of our seas preserves the original inhabitants of this area, remnants of the fauna of the glacial epoch, overlain and surrounded by a fauna of later migration, and adapted to a higher temperature. A curious fact respecting the marine creatures of the Arctic seas of Europe, viz., that the littoral and laminarian forms are peculiarly arctic, whilst the deeper species are boreal or celtic, may be explained also by the influences of warm currents flowing northwards and diffusing the germs of species of more southern regions in the coralline and deep-sea-coral zones; for in the arctic seas the temperature of the water is higher at some depth than near the surface. On the other hand, we find in a region farther to the south than Britain, an outlier of the Celtic fauna preserved in the bays of Asturias, where it was discovered in 1849 by Mr. Mac Andrew; a very remarkable fact,

and one appealed to by the lecturer as confirmatory of his theory of an ancient coast extension between Ireland and Spain.

There is still much to be done in the investigation of the natural history of our seas, and many districts remain for more minute exploration. It is chiefly among articulate animals and especially among worms that fresh discoveries may be looked for. Yet even now, new and remarkable forms of mollusca may occasionally be procured, and during the autumn of last year in a cruise with Mr. Mac Andrew, no fewer than twenty additional molluscs and radiata were discovered in the Hebrides, and have just been described by the lecturer in conjunction with Professor Goodsir. Among these is one of the largest, (if not the largest,) compound ascidians ever discovered. In our southernmost province, fresh and valuable researches have been conducted during the past year by Professor Acland and Dr. Carus, who selecting the Scilly Isles as a field for exploration, have filled up a blank in our fauna.

The lecturer concluded by an expression of gratification at the spread and progress of natural history studies in Great Britain among all ranks, and at the love of science manifested in the systematic manner in which our fauna and flora have been explored, and the beautiful works which have been produced in illustration of them.

IV. Astronomy.

1. *New Planet Eunomia*, (Astron. Journal, &c.)—Another planet was discovered by M. de Gasparis, of Naples, on the 29th July, 1851. Its appearance was like that of a star of the 9th magnitude, and its apparent place at $11^h\ 44^m\ 53^s{\cdot}7$ m. t. Naples, was R. A. $18^h\ 15^m\ 59^s{\cdot}94$, and Southern declination 26° 3′ 54″.

The following elements of its orbit are published by Mr. G. Rümker of the Hamburg Observatory. They are computed from the Naples observation of July 29, and the Hamburg observations of Aug. 29 and Sept. 27.

1851, October 1·0, Greenwich m. t.

Mean longitude,	293° 49′ 51″·49	
Longitude of perihelion,	27 35 37 ·57	M. Eqx.
" " node,	293 52 54 ·76	Jan. 0. 1851.
Inclination,	11 43 42 ·75	
Angle of excentricity,	10 51 34 ·29	
Excentricity,	0·1884017	
Log. semi axis major,	0·4228496	
" mean daily motion,	2·9157322.	

2. *First Comet of* 1851.—Dr. D'Arrest at Leipsic, discovered a telescopic comet on the 29th of June, 1851, and from the observations of June 29, July 2 and 6, he computed the following elements.

Perihelion passage, 1851, July 6·35816 m. t. Berlin.

Longitude of perihelion,	324° 35′ 59″·8	App.
" " Asc. Node,	152 41 33 ·2	Eqx.
Inclination,	14 43 38 ·8	
Log. perihelion distance,	0·0892774	
Motion,	Direct.	

M. Yvon Villarceau finds from his computations that this comet is a periodical one, and that its time of revolution is about eight years. There is some probability of its identity with the comet observed in 1678 and computed by Douwes.

3. *Second Comet of* 1851, (Astr. Jour.)—On the first of August, 1851, Mr. Brorsen, at the Senftenberg Observatory, discovered a telescopic comet in the constellation *Canes Venatici*.

The following elements have been computed by Mr. C. W. Tuttle, second assistant at the Harvard Observatory, from the observations there taken August 23, 26, and 29.

Perihelion passage, 1851, Aug.	26·46269	Gr. m. t.
Long. of perihelion, . .	311° 3′ 38″	} M. Eqx.
" " node, ...	215 30 45	} Jan. 0. 1851.
Inclination, ...	37 41 22	
Log. perihelion distance, . .	9·98876	
Motion, ...	Direct.	

4. *Aurora Borealis of September 29th*, 1851.—The Auroral display of Sept. 29, 1851, was witnessed in the Southern States to an unusual extent. From a very interesting account of his observations on that occasion, which Prof. Lewis R. Gibbes has published in the *Charleston Evening News*, Oct. 3, 1851, we make the following extract, referring to an hour when in this latitude, the streamers passed our zenith, and extended downward ten degrees or more below the coronal point.

"At ten minutes before 8, a bright and well-defined auroral arch was seen just above the northern horizon, and continued visible more than half an hour, becoming somewhat brighter, and rising a little higher than at first. At $8^h\ 15^m$ a sketch of its position was taken. * * This moment proved to be nearly that at which the arch was most brilliant and best defined, and from this position it did not afterwards much vary. The vertex of its upper boundary was about 3° or 4° to the east of a vertical drawn through the Pole Star, and about half a degree lower than the parallel of altitude passing through Alpha of the Great Bear, which was about ten degrees to the west of the vertical; curving from this point downwards to the horizon, on the west it passed about a degree or a little more below Alpha in the Great Bear, and very near Gamma in the same constellation, on the east near Delta in Auriga, and a degree and a half below Capella in the same constellation, its two extremities in the horizon embracing an arc of about 80° of that circle. The breadth of the arch was about equal to the interval between Epsilon and Zeta in the Great Bear. The arch was surmounted with rose-colored or purple-colored rays, of moderate brilliancy, normals or perpendiculars to the arch in their several positions, nearly equal in length, and those near the vertex of the arch reaching about two-thirds the distance from the arch to the Pole Star. The arch itself was of a bright white light, tinged with green, arising perhaps from contrast with the rose-colored rays, the whole forming a really magnificent spectacle, especially for our climate."

5. *Note on the Aurora Borealis of Sept. 29th*, 1851; by Prof. J. Le Conte, (from a letter to one of the editors, dated Athens, Geor-

gia.)—There was an unusually brilliant display of the Aurora Borealis at this place on the evening of the 29th of Sept. 1851. It commenced at evening twilight and continued until 11 o'clock at night. The hazy luminous arc from which the streamers proceeded, extended from the north to the northeast point of the horizon, embracing an amplitude of 45° or 50°. The streamers were observed to shoot up to an altitude of 40°. The color varied from orange-red to white. As far as my recollection extends, it was the most magnificent exhibition of the phenomenon I have ever witnessed in *this* latitude (33° 58′). I notice that it was seen as far south as St. Simon's Island in lat. 31°; and it is probable that it was visible as far south as Key West.

6. *Account of a Reflecting Telescope constructed by Mr. Josiah Lyman, of Lenox, Mass.*, (sent for publication in this Journal, by Prof. A. Caswell.*)—Mr. J. Lyman, late Principal of the Academy of Lenox, Mass., has recently manufactured a *Reflecting Telescope*, (finished in June last,) of the following dimensions, and description. The focal length is 16 feet. Aperture 9½ inches in the clear. The tube is composed of thick Russia iron, painted and varnished; the parts being fastened together by brass bands with screws. The arrangement for observation is that of Herschel and Lord Rosse; the finder being placed on the left of the front end of the instrument, (left to a person facing the object viewed,) and the eye-tube on the right. The lower end of the instrument has attached to it a frame-work, terminating in Ys, and resting upon two pivots at the ends of a horizontal axis. In the center of this axis is a socket working upon a vertical axis, rising from the center of a tetrapod which rests upon the ground or floor of the observatory, as the case may be. The front end of the telescope is supported by two legs lengthened or shortened at pleasure, by a combination of cranks, cords and pulleys; the whole so contrived as to allow of every necessary motion with smoothness and uniformity, without any cramping of the parts. With this mounting, the instrument may be either portable or stationary. In the latter case, declination

* Prof. Caswell, in sending the above for this Journal, writes to the Editors as follows:—"The following account of the Reflecting Telescope constructed by Mr. Lyman of Lenox, Mass., has been placed in my hands, with the request that if I approved the same I would forward it for publication in your Journal.

"During the recent meeting of the American Association at Albany, a Committee, of which I was a member, was appointed to examine and report upon Mr. Lyman's telescope. The unfavorable state of the weather prevented their testing its optical power by observations of any of the heavenly bodies, and consequently no report was made.

"I examined the construction, mounting and mechanical adjustments of the instrument, and am happy to say that they appear to me to be very good. The mounting and mechanism are such as to secure steadiness, smoothness, and sufficient freedom of motion. The testimony of Prof. Alexander as to its performance on close double stars is very satisfactory.

"Mr. Lyman deserves great credit for bringing so arduous an experiment to a successful issue. His telescope, in point of optical power, is, so far as I know, much in advance of any thing heretofore achieved in this country. It is no small matter to have constructed an instrument, which, under favorable circumstances, will separate double stars distant from each other by no more than *half a second of arc*. The fact is worthy of being known, and I hope Mr. Lyman, by the success of the present effort, will find encouragement to aim at still greater success.

Brown University, Oct. 17, 1851."

and azimuth and even hour circles, may be used in connection with the foot-piece if desired.

One of the peculiarities of this instrument is, that the large speculum is held in its position by a system of triangles so arranged as to produce perfectly uniform pressure upon the lower surface; and even the slight pressure requisite is mainly counteracted by antagonist pressure upon the face.

But the great excellence of this telescope lies in the remarkably *accurate figure of the speculum.* The singularly sharp outline of the stellar disks, the great clearness of the components of almost the closest multiple stars, the very satisfactory performance on the clusters and nebulæ seem nearly to evince entire absence of *spherical aberration.* Indeed, the figure must be a *very close* approximation to the *parabolic curve*, if it is not the very curve itself.

Previously to the 23d of July, on account of the state of the atmosphere, Mr. Lyman had been unable to use a power higher than 275. But on that evening the instrument admitted of a power of 550 with perfect clearness of the image, and for an hour or so, would, he believed, have admitted of 800 or 1000. In company with a couple of his neighbors, he examined π Aquilæ, τ and λ Serpentarii, the components distant 1″ each according to Struve and Maedler. With a power of 550 the separation was perfectly distinct; and one of the gentlemen said, had the distance been but $\frac{1}{2}$″, he believed the separation would have been complete; and there was reason for this opinion, for they examined the last named star with a power of 275, and the separation was clear to them all.

Of an examination of several celestial objects at the Albany Academy (at the conclusion of the late meeting of the "American Association for the Advancement of Science,") at which several gentlemen were present, Mr. S. Alexander, Professor of Mathematics and Astronomy, of the College of New Jersey, speaks as follows:

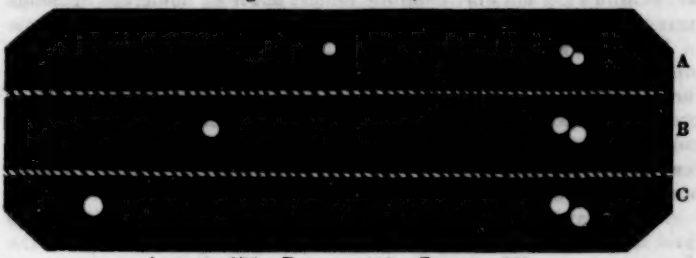
"I was present at a partial trial of the sixteen feet reflecting telescope made by Mr. Josiah Lyman, on the evening of August 23d. The night was a tolerably favorable one; the amplifying power about 275. The two component stars of π Aquilæ, were satisfactorily separated; the cluster in Hercules presented somewhat of a granular appearance even at the center; and the large nebula in Andromeda showed a variation of light at the center, as though with greater light and power it might have been resolved. I have been accustomed to the use of a refractor; but I could not help regarding the performance of Mr. Lyman's telescope as highly satisfactory.

Albany, Aug. 25, 1851."

On the evenings of August 28th and 29th, at Lenox, Mr. L. tried the instrument on ε Equulei, in company with several individuals, among whom was Dr. Sabin, a physician of that place, and on the latter evening Dr. Skinner and lady, of New York city. The appearance was precisely as represented in the following diagram, which has been shown to all the persons who observed, and approved by them. The description of this star in Kendall's Uranography, published in 1844, and taken from the latest observations of Struve and Maedler, is this. "—— a triple star of the 6th, 6th and 7th magnitudes, whose distances

are $\frac{1}{2}''$ and $11''$." Mr. Kendall remarks in respect to τ Serpentarii, that in the 14 feet refractor used by Struve at Dorpat, in 1828, it appeared single.

Appearance of ε Equulei, as seen in the 16 feet Reflector at Lenox Aug. 28th and 29th, 1851.



A, power 275.—B, power 410.—C, power 550.

The relative distances of *the centres* in this diagram are taken from Kendall's description; no micrometers being at hand in this observation. But the distances of the *outlines of the disks of the closer stars* is precisely as the telescope showed them with the specified powers.

In 1835 the stars were seen in contact; the distance was $\frac{2}{5}''$. Of γ Virginis, he says: "In 1836 the components were so close that no telescope in the world would separate them; the distance was $\frac{3}{10}''$." The Dorpat telescope with a power of 1000, (according to Kendall's cut,) showed them overlapping each other nearly $\frac{1}{3}$ the diameter of the smaller stars. The inference is, that the Dorpat *Refractor* was limited in its resolving power to about $\frac{1}{2}''$. And it is equally clear that the *Reflector* made by Mr. L. would resolve stars somewhat *closer* than $\frac{1}{2}''$.

On the evening of Sept. 5th, 36 Andromedæ was easily resolved by five or six gentlemen of Lenox, with a power of 275.

Mr. L. and two other gentlemen examined ε Arietis, on the evening of Oct. 9th. This star is thus described by Kendall.

"ε, in the hinder part of the back; both white; of the 6th magnitude; distant half a second." It was distinctly separated with a power of 410, and with 550 the division was *steady and constant*. They believed this star to be a little more difficult and a little *closer* than ε Equulei. Moreover, inasmuch as it is not even *suspected* of being a *binary system*, and the distance of the components consequently remains unchanged, it was an extremely satisfactory test observation.

V. Miscellaneous Intelligence.

1. *Notes on Vesuvius, and Miscellaneous Observations on Egypt*, (from letters to the Smithsonian Institution, from a traveller in the East; communicated for this Journal.)—*Vesuvius.*—At Naples we had the good fortune to witness an eruption of Vesuvius, and we ascended the cone a day or two before the flow of lava commenced. An American who went up a week earlier found the crater empty, but at our visit it was very nearly filled up with scoria and was emitting smoke from two openings, where the red-hot (but not fluid) matter could be seen, as

well as from numerous smaller crevices. During the eruption I made several visits to the mountain and observed its phenomena as well as I was able with so imperfect means. The ejections consisted of vapor, sulphurous gases, volcanic sand, steam, fragments of lava from the cone, and of several currents of fluid lava. The vapor and the gases were thrown out not only from the crater, but from numerous openings near the summit of the cone, and they also accompanied the currents of lava, both at their source and along their course. The sand was in less quantity than has been often observed, scarcely covering the ground three or four miles from the crater, though in some places it fell in greater abundance. The smoke occasionally settled down so as to conceal the whole cone, which, as you will remember, is about 1500 feet in perpendicular height; but as there was a brisk north wind during almost the whole eruption, the summit of the cone was generally visible. The lava was thrown up from the cone in red-hot and doubtless fluid masses, of such diameter as to be visible to the naked eye at the distance of two or three miles by day, and much farther by night. Of these masses, a large proportion fell back into the crater, which is one-third of a mile or thereabouts in diameter, but vast numbers fell without. These were generally hardened before they struck, but some remained in a semi-fluid, or at least plastic state, which, however, continued but a few seconds. It was very difficult to determine the height to which these fragments were thrown, by observing the time of their fall, because they could not readily be distinguished among the thousands of others which were rising and falling at the same time, as well as for other reasons; but I succeeded in satisfactorily measuring the time of the descent of several of the larger masses. The longest times I observed were seven, eight, and in one instance ten seconds. The explosions by which the fragments were thrown up occurred at pretty regular intervals of eight seconds or thereabouts, but the rise of them was scarcely at any time quite intermitted. Although the guides affirmed the contrary, I do not believe the lava flowed over the edge of the cone at any time. The only currents I was able to discover, burst out at various points, the highest being about one-third above the base of the cone. The difficulty of reaching these mouths was considerable, and I attempted it but twice, approaching on both occasions within fifteen feet of the outlet. The lava was here thrown out in a rapid current, or rather spout, and at short intervals bubbles would burst from the orifice and throw fragments from a few inches to two or three feet square to a considerable distance. I secured one of these which fell at my feet, and imbedded a large copper coin in it while it was yet soft, and brought away also a smaller fragment which struck my leg. After this orifice had ceased to flow, I visited it and estimated it to be twelve feet or more in diameter. While the lava was flowing from it, the velocity of the current at the moment of its escape could not well be estimated, but I succeeded twice, in spite of the suffocating vapor, in approaching quite near the current a hundred yards below, and by watching the motion of the scoria which fell upon it from a bank of hardened lava, and throwing stones upon it (which floated like wood on water) I satisfied myself that it here flowed, though in a much wider stream than at the point where it issued, at the rate of four miles

an hour. Though in broad daylight, the color was a bright cherry red, there were no scoria formed on the surface, and the motion was to the eye very like that of a mountain brook swollen by rain.

In the early stages of the eruption it was not accompanied by any loud sound, nor did I hear that an earthquake was observed; but after the eruption had continued a few days, the roar of the mountain could be distinctly heard at Naples, and at the foot of the cone it was appalling beyond any sound I ever listened to. It was not till the eruption began to abate that any electric phenomena were observed in the cloud of smoke, but from this period flashes and chains of lightning with thunder, easily distinguishable from the roar of the mountain, were frequent. I also visited the lava at two points, distant probably two miles or more from the outlet. It here presented a vast wall ten or fifteen feet in height, composed of red-hot scoria and stones, and was then moving through vineyards of great extent (and with trees of six or eight inches in diameter, as supports to the vines) at the rate of about twenty yards the hour. A quarter of an hour after we left one of these points, a new outburst from the mountain suddenly urged forward the whole mass a distance of two hundred yards, prostrating a church and several cottages and burying the road over which we had just passed. Upon the whole it was the most interesting natural phenomenon I have ever witnessed, and it was with no small regret that I left Naples before the eruption had entirely ceased.

Egypt, &c.—I found the climate of Egypt neither so warm nor so dry as I had expected. We had rain at Cairo twice between the 10th and 20th of January, and at Esneh, in Upper Egypt, we had a rain storm of twenty-four hours' duration. There was another heavy shower, accompanied with thunder and lightning, which extended from Cairo several hundred miles southward, about the middle of April, and we often saw traces of heavy rains in the neighborhood of the river. The form, if one may so speak, of the lightning flashes, in the April storm, was peculiar, resembling the zigzag branches of a tree with spires at every angle. Almost all the *near* discharges appeared of this character, which, however, though new to me, may be a very common one. Among other atmospheric phenomena, I may mention that the *zodiacal light* was distinctly visible *every* night, except when the light of the moon was too great, from January to June, and in all latitudes from 21° 45′ to 31°, and that on one occasion, we saw clearly three of the satellites of Jupiter, with the naked eye, at Cairo. I may add that while on the eastern shore of the Gulf of Suez we observed at 1 P. M., at an altitude of about 50°, and upon the same side of the zenith with the sun, a long, narrow, right lined stratus cloud, exhibiting as distinctly as a rainbow the prismatic colors, the red being uppermost or towards the sun.

From January to May the thermometer on the river stood at about 50° at sunrise, and rose to from 75° to 85°, and once to 93° in the hottest part of the day. From the 10th to the 15th of May, when we were between Suez and Mount Sinai, the mercury rose every day to from 100° to 116° in the shade, but at Mt. Sinai it fell to 54°, with thunder, rain and hail, and, with the exception of a single day at Akaba, the weather was not only cool, but almost cold until July. We were

about forty-five days in the desert, and made the entire journey on camels. I was exceedingly interested in the physical geography of Arabia, and with the exception of Northern Syria, which is far richer in fossils, I doubt whether there is anywhere a better field for the study of igneous and metamorphic rocks. The mountain group of the Sinaitic peninsula rises to the height of 8000 feet, and as the whole chain is devoid of vegetation, and completely bare of earth, the rock formations, with their innumerable dykes and other effects of igneous disturbances, are completely exposed to view for very great depths. The wadees, or valleys between the mountain ridges, are filled in winter by violent torrents, and, as all the mountains of the peninsula are in a state of advanced degradation, these torrents bring down into the valleys innumerable specimens of every species of plutonic rocks, and one may gather a fine mineralogical collection without pickaxe or hammer; though, of course, the referring of them to their original locality would be no easy matter, and it is sometimes very difficult to imagine how, with the present configuration of surface, they could ever have been transported by water from their original beds to their present places of deposit.

The particular locality which interested, I might say enchanted, me most, was the head of the Gulf of Akaba (Aclanitic gulf) near the island of Graia. Here the mountains meet the sea, and the camels wade around the promontories. The conditions of rock and water are here eminently favorable to the formation of conglomerates, and you see them in every stage from a mere agglomeration of fragments of granite, syenite, porphyry, basalt, &c., mingled with recent shells and corallines, to that of a silicified and water-worn rock, composed of the same materials. This part of the sea is also filled with marine plants and corallines in great variety, and of striking forms, among which swim the most gorgeously painted fish I ever conceived of. All this, alas! one must see from his camel's back, for Akaba has not a single boat, or even a palm tree raft.

March 14, 1851.

2. *Effects of Lightning;* by Wm. Coffin, Professor of Mathematics at Illinois College, Jacksonville, (communicated for this Journal.)—On the 21st of August, a boy, (son of R. Yates, Esq., our representative to Congress,) was passing home from his next neighbor's and was killed instantly by a stroke of lightning. The two houses were only 250 feet apart, and he was within 50 feet of the one he had just left. It was in a part of the town thickly settled, the boy being in the only vacant lot near. There was a lightning rod on his father's house but none on the one nearest him. There were no trees or high objects of any kind nearer than the houses. The telegraph wire passes about 150 feet from the spot, parallel with the direction in which the boy was going.

The only marks upon the boy were a few small spots on the forehead probably caused by heat and not extending below the cuticle. His eyebrows and front hair were considerably singed. His hat (a common straw hat) had a hole three inches in diameter knocked through the front crown. Most of the straw was carried entirely away,

and around the edges of the hole all the straws were pointing upwards. There were no other marks on his body or clothes, nor on the ground where he stood.

The appearances of the storm were as follows. The first part of the day was clear and pleasant; but about one o'clock, clouds were noticed in various parts of the heavens, and there were many indications that we were about to have one of the sudden, severe, but short thunder showers which are of frequent occurrence here. Soon after two o'clock, two clouds were seen to rise rapidly and approach the zenith, one from the north, the other from the southwest. Frequent flashes of lightning were seen from them, showing that both were thunder clouds. Soon after the stroke by which the boy was killed, these two clouds met and passed off together to the southeast, and in a short time the sky was clear again. At the time the boy was killed, the cloud from the north was almost directly over his head.

I have thus simply given the facts of the case. There are several things remarkable about it. It is the first case, so far as I know, of death by lightning in the open air in the midst of a town. The appearances of the hat and the clouds indicate that the boy was killed by a "*return stroke;*" the electricity passing from one cloud to the other and taking the earth and the boy in its circuit. The houses west and south of the spot are well supplied with lightning rods and perhaps the electricity passed silently from the cloud to the earth by these and accumulated at the very spot where the boy was passing. I have been asked repeatedly, "whether the telegraph wire had anything to do with it?" My answer has been that I could see no way in which it could have.

3. *Coating Metals: Henry Grissell's (of the Regent's Canal Iron-works) improvement in coating metals with other metals.* Patent dated January 11th, 1851. Enrolled July 10th, 1851, (London Patent Journal.)—The patentee's improvements in coating metals with other metals are as follows:—

Coating Iron with Zinc.—For this purpose the patentees use a bath or vessel of iron, or other suitable material, in which, by means of heat, they melt the zinc, and on the surface of the melted zinc place a thick layer of chlorid of zinc (prepared by dissolving zinc in muriatic acid, and driving off the water,) or a mixture composed of 8 parts of chlorid of zinc, and 10 parts of chlorid of potassium, or a mixture of equal parts of chlorid of zinc and chlorid of sodium, or chlorid of potassium. When the metal and the salt are in a state of fusion, the iron to be coated with zinc is dipped into the metal, through the covering of fused salt, and becomes coated with zinc. If, however, it is found that a sufficient quantity of zinc has not adhered to the iron a small quantity of sal-ammoniac, in powder, is sprinkled over the iron, which is again dipped into the melted zinc. Under this part of their invention, the patentees claim the use of chlorid of zinc applied as above mentioned in the fused state; also of the mixtures of the various salts above enumerated.

Coating Zinc, Iron coated with Zinc, or other Metal, with a Metallic Alloy.—For this purpose the patentees use a vessel of iron, or other suitable material, in which the alloy is melted. One of the alloys

used by them is composed of zinc 10 parts, tin 26 parts, and lead 5 parts. A layer of chlorid of zinc mixed with an equal weight of sal-ammoniac is kept in a state of fusion on the surface of the metal alloy, the temperature of which must not be carried higher than is sufficient to keep the alloy in a fluid state. The metal to be coated is dipped into the melted alloy, but not allowed to remain therein longer than is absolutely necessary to receive a coating of the alloy. The patentees use also the alloy called "fusible metal," which they prefer to make as follows: bismuth 8 parts, lead 5 parts, and tin 3 parts; alloys of other compositions will do, provided that their melting points are below 400 deg. Fah. The patentees claim the use, in the manner above stated, of the alloys specified and referred to, and of the method above described for coating metals with such alloys.

Coating Iron or other Metal with Tin, or Tin alloyed with Lead.—For this purpose the patentees use a vessel of iron, or other suitable material, in which the tin or alloy is melted, and on the surface of the fused metal lay a stratum of chlorid of zinc, mixed with about its own weight of sal-ammoniac. The metal to be coated is then dipped into the liquid metal or alloy, until the coating is effected. The patentees state that it will be found advantageous, in the use of this and the preceding processes, to dip the metal to be coated several times, in order that it may come in contact often with the layer of fused salt; also advantageous in the preceding process to dip the iron or other metal into a hot and slightly acid solution of chlorid of zinc, previous to immersion in the bath of melted metal. The patentees claim, under this head of their invention, the use of a mixture of chlorid of zinc and sal-ammoniac, forming a saline compound, which is kept in a state of fusion on the surface of the melted tin or alloy, in the process of coating metals with other metals.

Coating Iron or other Metal with Silver, or Alloy of Silver and Copper.—In this case, the surface of the iron or other metal to be coated is to be first amalgamated in the usual way. The patentees prefer to use for the amalgamating process, a mixture of 12 parts of mercury, 1 of zinc, 2 of sulphate of iron, 2 of muriatic acid, and 12 of water; the mixture to be heated, and, when 200 deg. Fah., the iron to be amalgamated is placed in the mixture, and the mercury rubbed on the surface of the iron. The silver, or alloy of silver, is then melted in a crucible, placed in a suitable furnace, and the amalgamated metal is dipped into it until it has acquired a proper coating of the silver or alloy employed.

Under this head, the patentees claim the process of coating iron or other metal with silver, or alloy of silver and copper, by amalgamating the surface of the metal to be coated, and then putting it into the melted silver or alloy.

Coating Iron with Copper, Brass, or any Alloy of Copper, with Zinc, Tin, or Lead.—In this case, the copper or alloy used is melted in some suitable vessel, and on the surface of the melted metal is placed a layer of borosilicate of lead, (composed of 112 parts of oxyd of lead, 24 of boracic acid, and 16 of silica,) and when the metal and the salt are in a state of fusion, the metal to be coated is introduced through the layer of salt into the melted metal, where it is allowed to

remain long enough to acquire a coating of the metal. The patentees sometimes coat the iron with zinc, or with tin, or even amalgamate its surface with mercury, in the way above mentioned, and then proceed to dip it into the melted copper or alloy. Another method of coating iron with copper or brass, is that of exposing it to the vapor of chlorid of copper, by placing that substance at the bottom of a copper crucible, in the upper part of which is placed the iron to be coated. The crucible is heated to redness, in a suitable furnace, and the vapors of the chlorid of copper volatilize and coat the iron with copper. If the iron thus coated with copper be placed in the upper part of a covered crucible, in which metallic zinc, covered with animal and other charcoal, is placed, and heat applied as in the above case, the vapors of the zinc rise, and, coming in contact with the copper-coated iron, convert the coating of copper into brass. Instead of chlorid of copper, a mixture of metallic copper and sal-ammoniac may be used, or a mixture of oxyd of copper and sal-ammoniac.

The patentees claim, under this head of their invention, the use of borosilicate of lead, in a fluid state, over a surface of melted copper or brass, or of the alloys above mentioned, in the process of coating iron by immersion; also, the process of coating iron with copper by the action of fused chlorid of copper, or the mixtures above named, and of coating with brass by subsequent treatment with vapors of zinc, as above mentioned.

4. *On the Gamboge Tree of Siam;* by Dr. Christison, (Proc. Roy. Soc. Edin., Jan., 1850, p. 263.)—Although gamboge has been known in European commerce for nearly two centuries and a half, and its applications in the arts have been extended in recent times, the tree which produces it is still unknown to botanists.

The late Dr. Graham, in 1836, was the first to describe accurately a species of Garcinia, which inhabits Ceylon, and which is well known there to produce a sort of gamboge, not, however, known in the commerce of Europe. Resting on a peculiarity of the structure of the anthers, which are circumscissile, or open transversely by the separation of a lid on the summit, he constituted a new genus for this plant, and called it *Hebradendron cambogioides*. At the same period the Author examined the properties of this gamboge, and found that it possesses the purgative action of the commercial drug in full intensity, and that the two kinds agree closely also, though not absolutely, in chemical constitution.

At an earlier period Dr. Roxburgh described, in his "Flora Indica," another species of Garcinia, under the name of *Garcinia pictoria*, which inhabits the hills of Western Mysore, and which also was thought to produce a sort of gamboge of inferior quality. In 1847, specimens of the tree and its exudation were obtained near Nuggur on the ghauts of Mysore by Dr. Hugh Cleghorn of the East India Company's service; and the author, on examining the gamboge, found it all but identical with that of Ceylon in physiological action, in properties as a pigment, and in chemical constitution. The same plant, with its gamboge, was about the same time observed by the Rev. F. Mason, near Mergui in Tavoy, one of the ceded Burmese provinces.

A third species, inhabiting the province of Tavoy, and also producing a kind of gamboge, was identified by Dr. Wight in 1840 with Dr. Wallich's *Garcinia elliptica*, from Sylhet, on the northeast frontier of Bengal. Its exudation was long thought to be of low quality. But, although this substance has not yet been examined chemically, it has been stated by Mr. Mason to be, in his opinion, quite undistinguishable as a pigment from Siam gamboge.

It is a matter of doubt whether Graham's character is sufficiently diagnostic to be a good generic distinction. But it was shown by Dr. Wight in 1840, that a well characterized section at least of the genus Garcinia consists of species which have "sessile anthers, flattened above, circumscissile, and one-celled;" and that all these species, and no others, appear to exude a gum-resin differing probably very little from commercial gamboge.

Still the tree which produces Siam gamboge, the finest and only commercial kind, continues unknown. A strong presumption however arose, that the last species was the Siam tree, as it grows in the same latitude with the gamboge district of Siam, and not above 200 miles farther west. But if the information recently communicated to the author be correct, the Siam tree is a fourth distinct species of the same section. In December last he received from Mr. Robert Little, surgeon at Singapore, specimens taken from two trees which were cultivated there by Dr. Almeida, a resident of the colony, and which were obtained by him "direct from Siam" as the gamboge tree of that country. These specimens are not such as to allow of a complete description; yet they are sufficient to shew that the plant presents the characters of Wight's gamboge-bearing section of the genus Garcinia; but that it is not any of the species hitherto so fully described as to admit of comparison with it. The fruit is round, not grooved, crowned by a four-lobed knotty stigma, and surrounded by numerous sessile or subsessile aborted anthers, and by a persistent calyx of four ventricose fleshy sepals. The male flowers consist of a calyx of the same structure, a corolla of four ventricose fleshy petals, and a club-shaped mass of about forty subsessile anthers, closely appressed, connected only at the mere base, one-celled, flattened at the top, and opening by a circular lid along a line of lateral depressions; and there is no appearance of an aborted ovary amidst them. These are the characters of the three species presently known. These three species very closely resemble one another in general appearance and special characters. The new species presents the same close resemblance to them all; and, in particular, its foliage is undistinguishable from that of *Garcinia elliptica*, the leaves being elliptic, acuminate, and leathery, exactly as described and delineated by Wight. But it differs from them all in the male flowers and fruit being peduncled. The male flowers are fascicled, and have a slender peduncle three-tenths of an inch in length. The single young fruit attached to one of the specimens has a thick fleshy peduncle, like an elongated receptacle, half as long as the male peduncle. All the other species hitherto described have both male and female flowers sessile or subsessile. As this difference cannot arise from a mere variation in the same species, the plant must be a new one. The evidence however that it produces gamboge, and more especially the commercial

gamboge of Siam, is not yet complete; and, until further information on this point be obtained, which the author expects to receive in the course of the year, it appears advisable not to attach to it a specific name. A question may even arise whether the male flowers and the fruit here described may not belong to two species instead of one; but this is far from probable.

5. *Patent for a Safety Paper granted to W. Stones*, (Chem. Gaz., Oct., 15, 1851, 400.)—The object of this invention is to manufacture a paper that will indicate by discoloration of its surface, when an attempt has been made to extract written characters therefrom; and thereby to afford to bankers, merchants, and others, protection against forgery, or the tampering with cheques, bills of exchange, and other important documents.

The invention consists in the employment of iodine or bromine, together with ferrocyanid or ferricyanid of potassium and starch, either in the manufacture or preparation of Safety Paper. For this purpose, iodine or bromine is used, in any of their ordinary combinations, with bases; but iodine being the cheaper material, is preferred to any compound of bromine. Of the compounds of iodine, the patentee employs in preference that known as iodid of potassium, such substance being the most readily attainable in the market, and in no degree affecting the color of the paper. The mode of applying this substance is by mixing it with the pulp or size, or the paper may be saturated with a solution of the metallic iodid. The ferrocyanid or ferricyanid of potassium is mixed with the size, or it may be applied subsequently to the sizing, as in the case of the metallic iodid. The starch is preferred to be mixed with the pulp in the engine; but it may, like the other chemical ingredients, be used in an after stage of the process.

The proportions for these several materials, used for rendering paper sensitive to the action of reagents, are by no means absolute; but as a guide it may be stated that the following have been found to answer the purpose, viz.: for a ream of post weighing about 18 lbs.—

1 oz. iodid (or bromid) of potassium,
$\frac{1}{4}$ oz. ferrocyanid (or ferricyanid) of potassium,
1 lb. starch.

On the application to paper, prepared as above set forth, of reagents, to dissolve out or absorb any ink-markings therefrom, the tendency will be to break up one of the salts named. Thus, on the application of chlorine or mineral acids, the iodine will be liberated, and, combining with the starch, will form an insoluble iodid of starch of a dark color; and, further, the iron, which ink generally contains, being attempted to be dissolved by either vegetable or mineral acids, the ferrocyanid of potassium will combine with it in solution, and form the well-known prussian-blue compound, which will become diffused over the adjacent portion of the paper.—Sealed Feb. 24, 1851.

6. *On the Manufacture of Candles;* by W. Carpmael, Esq., (Proc. Roy. Soc., Feb. 21, 1851, p. 21.)—Formerly the classes of candles manufactured in this country were wax, spermaceti, and tallow, the materials being used almost in their natural state.

The manufacture of *wax* into candles has received no improvement, but is still a rude process, consisting of hanging a series of wicks (each

composed of several yarns of Smyrna cotton slightly twisted together) around a hoop suspended in the air: the workman pours the melted wax on to the wicks in succession till the candles are about one-third made, when they are allowed to cool for a time: then again the process of pouring on the melted wax is repeated, till the workman judges, by sight or by weighing, that the candles are about half made; when they are again allowed to cool and set for a time, after which the candles are rolled on a slab of marble. The upper part of the candle is formed by cutting away the wax down to a metal tag, which covers one end of the wick. The candles are then again suspended to hoops, the end of the wick which had previously hung downwards being now upwards; and the process of pouring on melted wax is again repeated, and the candles finished to the desired size, when they are again submitted to the process of rolling between two smooth surfaces; the lower ends are cut off, and the candles are finished. The bees-wax employed before being thus used is bleached, and is generally mixed with a quantity of spermaceti.

The next class of candles to which attention was called was *spermaceti*, of which material many hundreds of tons are annually brought to this country. This material in the manufacture of candles is mixed with about three per cent. of bees' wax, to prevent the spermaceti crystallizing. Formerly spermaceti candles were inferior to those made of wax, the same class of wick being used. Some years ago, platted wicks were substituted for the twisted wicks before employed: this was a great step to improvement. Platted wicks have a tendency to turn out of the flame while being consumed, the effect of which is to cause the wicks to be burned away, rendering the use of snuffers unnecessary. Since that time spermaceti candles, in place of being considered inferior, are preferred by many to candles made of wax. They are made by pouring the melted material into pewter moulds in which platted wicks are first inserted, and retained securely in the centre of the moulds. Other candles also are made of mixtures of wax and spermaceti, called composition candles.

Mr. Carpmael next called attention to the manufacture of *tallow* candles,—"dips" and "moulds." The former are made, as is generally known, by suspending several wicks a short distance apart, (each consisting of several cotton yarns) on a rod; the wicks are dipped several times into melted tallow; the coats thus taken up are allowed to cool and set. The mould candles are produced by pouring the melted tallow into pewter moulds in which proper wicks (each of several cotton yarns) are first fixed centrally. These wicks require snuffing. A great improvement was some years back introduced into this manufacture by employing cords of cotton as wicks, which are coiled spirally round wires. The wires and the coiled wicks are introduced into moulds, and the wires are withdrawn when the tallow is set. These candles will, however, only burn in lamps, the turning out of the wicks melting the candles down on one side. This improvement introduced a new manufacture of lamps called candle-lamps, which of late years have greatly increased in use; various sizes of candles being now made, some having as many as four wicks, and suitable for large table lamps. This manufacture has been greatly improved by the introduction of several

means of making wicks which will turn out of the flame, and yet will admit of being introduced in a straight line within a candle. Attention was called to several descriptions of wicks for this purpose: they all act, however, on one principle, that of having a preponderance of strength on one side, which may be done in a great variety of ways. One of the most simple is the ruling of a line on one side with paste, which gives additional stiffness or strength to that one side, and such wicks in burning turn out of the flames. Following out this principle, the wicks may be modified to suit the various requirements of the different materials employed in candle-making, each of which requires a different character of wick. This was shown by several candles being burned having wicks slightly differing from those which were best for each particular case, proving that great observation and skill is requisite in the manufacturer in order to adjust the material and wick to each other in every case. Attention was also called to the fact, that up to the present time, manufacturers have not been able to employ platted wicks in wax candles or tallow candles.

Ordinarily in making mould candles the wicks are placed by hand into the moulds, and the same are retained fast therein by pegs at one end and by wires at the other. A great improvement has been introduced into this part of the mechanical processes, by causing the candles as they are discharged from the moulds to draw fresh wicks into the moulds; and on the candles being then cut off from the wicks an instrument takes hold simultaneously of all the wicks and retains them correctly in position in the several moulds.

About thirty years ago a celebrated French chemist (Chevreul), when investigating the properties of fatty matters, discovered that they consisted of certain acids; and many efforts were made to introduce one of the acids (stearic acid) into the manufacture of candles, but with little if any practical effect, owing to its highly crystallizing properties. In order to correct this properly, recourse was had to the use of arsenic, which was found to break up the crystals; and candles were extensively made and consumed, rivalling spermaceti in appearance, whilst they were sold at a much less price. But public attention having been called to the injurious effects produced by the vapors of arsenic thrown off by such candles, this greatly increasing manufacture met with a severe check; and if the manufacturer had not discovered a means of employing stearic acid without arsenic in the manufacture of candles the public would probably have ceased to purchase them. This probably is one of the most interesting events in the history of the manufacture. On investigation it was discovered that the cause of the crystalline character found to prevail in stearic acid candles is consequent on the pouring very hot melted stearic acid into cold moulds; and it was found that by pouring the matter when nearly set into moulds warmed to about the same temperature as the candle-stuff, and by using a small quantity of wax, candles of stearic acid can be made possessing very excellent properties. Hence this class of candles has of late years very largely prevailed, which, being made with suitable platted wicks, like spermaceti candles, do not require to be snuffed.

Another class of candles which came largely into use about the same time was produced from the stearine of cocoa-nut oil; but this candle

required snuffing. A great step of improvement in the manufacture of candles resulted from combining these two matters, viz., stearic acid of tallow with stearine of the cocoa-nut. It is found that stearic acid of tallow burns with a somewhat red flame and is liable to smoke; it contains too large a quantity of carbon: whilst the stearine of cocoa-nut oil contains too much hydrogen, and burns with a white flame. The effect of combining these two matters was to obtain a better flame than either, when used separately. The product is cheaper, and will also admit of the use of platted wicks; and the tendency of the stearic acid to crystallize is corrected by the employment of the stearine of the cocoa-nut. These candles are known by the name of "composite," and have been sold in immense quantities.

Mr. Carpmael next called attention to the modern introduction of palm-oil in the manufacture of candles, the properties of which are peculiarly suited to candle-making. The *stearine* of it, even in its crude state makes excellent "dip" candles when the quality of the light only is considered; but they are of a bad color. The palm stearine also makes good lamp-candles; but the great use of palm-oil as a candle-stuff is when distilled for this purpose. The crude oil is first treated with acid to bring it into an acid state, and the same is then distilled by means of steam, which in its passage from the boiler passes through a series of pipes heated by a furnace, by which the steam becomes very highly heated (600° Fah.) and in that state it enters into the still, and amongst and below the chemically prepared palm-oil, which is thereby caused to distil over, and is condensed in suitable apparatus; the product is pressed: and by these means a most beautiful material closely resembling spermaceti is obtained, and from which those modern manufactures of candles now so largely and so well known as Belmont sperm and Belmont wax are produced.

The table was largely supplied with candles of every description of manufacture, by which the peculiarities of each class could be readily pointed out, and examined.

7. *On the Meteoric mass discovered at Schwetz;* by M. G. Rose. (Berlin Acad., Feb., 1851; L'Institut, No. 912, June, 1851.)—In the spring of 1850, while removing a hill of sand, in the grading of a railway, near Schwetz on the Vistula, a mass of iron, about 4 lbs. in weight, was found at a depth of 4 feet, at the limit where the upper sand covers the subjacent clay. The mass sent to Prof. Rose is somewhat prismatic in shape, about 9 inches (Prussian) long, with the thickness 5½ and 4 inches, a line around it lengthwise being 24 inches long, and transversely 17½ inches. The whole mass weighs about 43 lbs. (livres). There is a fissure cutting it somewhat diagonally. The outer surface is rounded and covered with hydrated oxyd of iron, and so also that of the fissure. A surface cut and polished and acted upon by an acid, exhibted fine Widmannstattian figures, much like those of the Texas iron. There is a mixture of some large and small grains of sulphuret of iron. M. H. Rose has detected in it nickel. It is in the hands of Rammelsberg for a complete analysis.

8. *Xenotime from the Gold region of Georgia.*—Prof. Lewis R. Gibbes in a letter to one of the editors dated Charleston, Nov. 21, states that about two years since he obtained in an excursion to the

mountains of Georgia a quantity of the refuse from the washings of a "pocket mine" of gold near Clarksville, Georgia, among which were small octahedral crystals affording, by the reflective goniometer, for the angle of the pyramid, 124° 45′, and for that over a basal edge, 81° 40′, which are the angles of xenotime. H=4·0. B.B. with borax and salt of phosphorus slowly dissolves to a colorless glass, and with soda effervesces readily and forms a cream-colored slag. The associated minerals in the "refuse" are zircon, rutile, kyanite, specular iron, garnet, and quartz. The mineral has been tested chemically for phosphoric acid by Mr. Craw of the Yale Laboratory, in accordance with a request from Prof. Gibbes, and an abundant precipitate of this ingredient was obtained.

9. *Xenotime in the Gold region of North Carolina.*—Prof. C. U. Shepard in a letter dated Dec. 1, states that he has detected crystals of xenotime among the sands of the gold washings of McDowal Co., N. C.

10. *Daguerrotypes.*—M. Aubrée has obtained daguerreotypes in thirty seconds with electric light. In two trials he used fluorid of bromine diluted with water. He also employed chlorobromid of lime, but with less success.

11. *Vegetable Parasites in Sugar.*—M. Payen has observed in sugar at Paris a parasitic vegetation which runs in cavities in lines, and changes the sugar to a reddish tint. The sporules of this cryptogamic vegetation were not over one to two thousandths of a millimeter in length. During the present year he detected in a refinery at Paris a variety of this vegetation without a reddish tint, occupying irregularly scattered cavities; its sporules are a little larger than in the reddish kind. The sides of the cavities are covered by a thin membrane from which the filaments proceed. This vegetation he refers to the Mucedineæ and has named it Glycyphila from the Greek γλυκυς, *sweet*, and φιλος, *lover*.

12. *Climate of Nischne Tagilsk, Urals*, (L'Institut, No. 921.)—M. Demidoff states the minimum temperature for *January* 1851 at −45½ F., and the maximum at +27½ F., on the sixteenth of the month at 4 P. M. The meam temperature of the month was +4¼ F. Snowed 29 times.

The minimum for *February* was −20° F.; the maximum +25¼ F. at 3 P. M. on the 15th; the mean +5¾ F. Snowed 19 times.

The minimum for *March* −25½ F.; the maximum +42 F., on the 29th at 3 P. M.; the mean +16½ F. Days of snow 27.

13. *Theory of Storms.*—Letters have been addressed by Lord Palmerston—as well as from the British Colonial office—to the various British Consuls requesting their co-operation in the collection of data towards a theory of storms, a plan urged by Col. Reid.—*Athenæum, No.* 1248, *Sept.* 27, 1851.

14. *On the Resuscitation of Frozen Fish;* by Prof. S. P. Lathrop, (from a letter to one of the editors.)—It is a fact well known to those who are accustomed to take fish—such as the common perch—*Perca serrato-granulata*, Cuv.; the lake mullet—*Catostomus oblongus*, Mitchell—from Lake Champlain in the winter, that these fish may be frozen perfectly solid and be transported many miles and kept several days, (and I do not know but an indefinite time,) when upon thawing them

out in a tub of cold water, they will be found to be alive and active. I once took some pains to corroborate this fact by inquiry, and found it to be well sustained by evidence though my eyes have not seen it. I find the same fact sustained in the case of the buffalo fish taken from the Rock river at this place.

15. *Cavendish Society.*—The Cavendish Society, is a voluntary association for the publication of such works or memoirs on Chemistry as otherwise would not be found in the English language. Their publications hitherto have been of an exceedingly valuable character. The chemistry of Gmelin, a work of vast learning in German, and by far the best treatise on the science, is now being issued in English by this Society, five volumes being completed; and various memoirs of French, German and Italian chemists are contained in their other volumes. The Society solicits subscriptions and we would direct attention to their announcement on our advertising sheet.

16. *University of Mississippi.*—Oscar M. Lieber, son of Dr. Francis Lieber of the University of South Carolina, was in July last elected Adjunct Professor of Geology in the University of Mississippi, to assist Professor Millington in the geological survey of that State, which survey is already commenced. J. M.

17. *William and Mary College, Va.*—George P. Scarbury of Accomac, one of the judges of the Circuit court in Virginia, has been elected to the Law chair in William and Mary College, vacated by the death of the late Judge Beverly N. Tucker. J. M.

OBITUARY.

Richard Cowling Taylor died on Sunday morning, the 26th of Oct., at his residence in Philadelphia, in his 62d year, after a very short illness.

The following are extracts from a notice of Mr. Taylor by Mr. Isaac Lea, published in the Proceedings of the Acad. Nat. Sci. Philad., for October, 1851.

"The first work of importance which he published, was one on the Monastic remains of the county in which his father lived as a country gentleman, and on whose property there was a noted Anglo-Norman ruin. It was this probably that induced Mr. Taylor first to turn his attention to this branch of knowledge, and the result was the 'Index Monasticus, in the ancient kingdom of East Anglia,' published in 1821, in 1 vol. folio,* which at once gave him a reputation for thorough investigation and exactness, which noted all his after works, and which has rarely been excelled. This work was received with so much favor, that Mr. Taylor was induced, at the request of the publishers, to undertake that thorough and learned work which he called a 'General Index to Dougdale's Monasticon Anglicanum,' in 1 vol. folio, with plates and maps, which was published in 1830. This took Mr. Taylor two years to complete, and was said to be so perfect as to require nothing further to be added in regard to it. In his profession, he had the great advantage of a most thorough and complete education, and he was

* At a public sale his private copy, with some notes, brought £30.

associated in business with the late Wm. Smith, who has been considered 'the father of British Geology.' * * *

He was soon called into active employment, and we find him engaged, for a time, in the important Ordnance survey of England; and he was also employed by the 'British Iron Company,' whose extensive and valuable property in South Wales, he investigated and reported upon. That portion of the Ordnance Survey which he executed, was finished in a masterly manner, and his drafts were of the most exact and perfect kind. His report on the topography and geology of the mineral lands of the British Iron Company, were so admirably executed, that the Geological Society of London published the map and descriptive parts in its Transactions. In connection with this, he executed a model in plaster of that part of Wales,* which received so much approbation, that the Society of Arts awarded him their *gold Isis Medal*, which is now in possession of his family. Subsequently to this, he was engaged for some years, in England, in the examination of various mining properties, after which he was induced to accept an appointment by Hardman Phillips, Esq., an intimate friend of the family, to remove to this country, and reside in Phillipsburg, Pennsylvania, where he remained four years, under the expectation of the professional employment promised him there. This was an unfortunate movement for himself and family, which now consisted of a wife and four daughters. Having lost, in this residence, both time and money, he removed to Philadelphia, for the purpose of seeking that employment in his profession, in which he was so well qualified to excel. Previous to this, however, he was engaged in the survey of the Blossburgh District, and the line of railroad, which he completed, and on which he made an extensive and able report in 1832.

* * * Shortly after this, Mr. Lea had it in his power to have Mr. Taylor placed in charge of the exploration of the extensive coal and iron property of the Dauphin and Susquehanna Coal Co., in Dauphin county, Pa., in which Mr. Lea had a large interest. Here Mr. Taylor remained about three years, and developed the mineral resources of this extensive mineral district, to the entire satisfaction of the Board of Directors. The whole of the lands embraced 42,000 acres, in a rugged, mountainous district, and required an experience and perseverance which few men had more of than Mr. Taylor. The result of this great labor was an elaborate report, of 187 pages in 8vo, together with about 150 maps, drafts, surveys and sections, which are invaluable to the Company, and in whose possession they now are. In connection with this, during a period of cessation of activity in such works in this country, he employed himself in the execution of a model of this part of the coal basin and its surrounding mountains, which occupied him many months. This subsequently became the property of the Dauphin Company. It embraces in length about 45 miles, and in breadth 15 miles of the district it represents, and is about 14 feet long. It is a complete geological and topographical representation of this important

* This was the first model of the kind executed in England.

district, and alone would be a monument to a man of science, if he had never executed any other labor."

The biographical notice goes on to mention his labors in various surveys, including that of the copper mines of Cuba, and then speaks of his very valuable work on the "Statistics of Coal," mentioned in this Journal, vol. vi, p. 150—a monument of vast industry, learning and judgment.

"Besides the proficiency which Mr. Taylor had acquired in economic geology, he had devoted himself much to theoretic geology, and his knowledge of the various formations, which make the sum of the geological series, was rarely excelled by his colleagues. He had devoted himself more particularly to the strata connected with the coal formation, and he was the first person, as Prof. Silliman stated to a meeting of the American Association of Geologists, who had referred the Old Red Sandstone, underlying the coal of this state, to its true position, corresponding with its place in the series of European rocks. * *

In the year 1832 he was elected a member of this Academy,* and in 1846 a life membership was conferred upon him, 'as a mark of respect and a just appreciation of its means of usefulness derived from him.' * * *

At the time of his death, Mr. Taylor was engaged in preparing a paper for the Journal of the Academy, on the fossil plants which he had discovered in his recent visit to New Brunswick. The fossil fishes which he had discovered there, he left with his friend, Prof. Agassiz, who was to describe the new ones for him. All these Mr. Taylor intended should be deposited in the collection of this Academy, to which he had already added many valuable specimens.

Mr. Taylor was the third son of Samuel Taylor, of New Buckenham, in Norfolk, England, and a descendant of Dr. John Taylor, the author of the Hebrew Concordance. He was born at Banham, in Norfolk, January 18th, 1789. His brothers and cousins were men generally remarkable for their great literary and scientific acquirements. His younger brother, Edgar Taylor, was a distinguished member of the legal profession in London, and an accomplished scholar. He was the author of several works, and remarkable for his numerous learned reviews, published in the most prominent periodicals in Great Britain. His cousin, Richard Taylor, is the well-known and able editor of the Philosophical Magazine, which has been the leading scientific Journal of England for the last twenty-five years. John and Phillip were equally distinguished as mining engineers.

The great services Mr. Taylor had rendered science, have been acknowledged, by his being made a member of the principal Societies in England and this country that embrace those branches of knowledge which he cultivated. He was elected a member of the Geological Society of London, and of the Society of Civil Engineers, of that place. In this country he was a member of this Academy, as before mentioned; of the American Philosophical Society; of the Geological Society of Pennsylvania; of the American Association of Geologists and Naturalists, of the Franklin Institute, &c. &c."

* Academy of Natural Sciences, Philadelphia.

List of Mr. Taylor's Memoirs, exclusive of his Professional Reports.

"Map of the Ordnance Survey," 1813–14, (probably the first.)

In the Trans. Geol. Soc. of London:—"Notices of two Models and Sections of about eleven square miles, forming a part of the Mineral Basin of South Wales, in the vicinity of Pontypool," (1830.) "On the Crag Strata at Bramerton, near Norwich," (1823). "On the Alluvial Strata, and on the Chalk of Norfolk and Suffolk, and on the Fossils by which they are accompanied," (1823).

In the Magazine of Natural History:—In 1829, on the "Progress of Geology;" in 1830, "Introduction to Geology," and "Illustrations of Antediluvian Zoology and Botany."

In the Transactions of the Geological Soc. of Pennsylvania:—"On the Geological position of certain beds, which contain numerous Fossil Marine Plants of the family Fucoides, near Lewistown, Mifflin county, Pa.," (1834). "On the relative position of the Transition and Secondary Coal Formations in Pennsylvania, and description of some transition or Bituminous, Anthracite, and Iron ore beds, near Broad Top Mountain, in Bedford county, and of a coal vein in Perry county, Pennsylvania, with sections." "Notices of the evidences of the existence of an ancient Lake, which appears to have formerly filled the Limestone Valley of Kishacoquillas, in Mifflin Co., Penn." "On the Mineral Basin or Coal Field of Blossburg, on the Tioga River, Tioga county, Penn." "Memoir of a section passing through the Bituminous Coal Field near Richmond, in Virginia." "Review of the Geological phenomena and the deductions derivable therefrom, in 250 miles of sections, in parts of Virginia and Maryland. Also, notice of certain Fossil Acotyledonous Plants in the secondary strata of Fredericksburg," Virginia.

In the Transactions of the American Philosophical Society:—"Memoir of the Character and Prospects of the Copper Region of Gibara, and a Sketch of the Geology of the N. E. part of the Island of Cuba." "Notice of Fossil Arborescent Ferns of the family Sigillaria and other Coal Plants, exhibited in the Roof and Floor of a Coal Seam in Dauphin county, Penn." "Notice of a Vein of Bituminous Coal recently explored in the vicinity of Havana, in the Island of Cuba." (This was conjointly with Mr. Clemson).

In Silliman's Journal:—"Notes respecting certain Indian Mounds and Earthworks in the form of Animal Effigies, chiefly in the Wisconsin Territory, U. S., with Plans and Illustrations." "Notice of a Model of the Western portion of the Schuylkill, or Southern Coal Field of Pennsylvania, in illustration of an Address to the Association of American Geologists, on the most appropriate modes for representing Geological Phenomena," (with illustrative sections).

In the Journal and Proceedings of the Acad. Nat. Sciences:—"Table constructed from a few Meteorological Notes, chiefly in regard to the daily temperature of noon, on the East Coast of the Isthmus of Panama, Port Royal, in Jamaica, and on the return voyage to New York, for the month of October, 1849." "Substance of Notes made during a Geological Reconnoissance in the Auriferous Porphyry region next the Carribean Sea, in the Province of Veraguas and Isthmus of Panama," 1851, with maps. At the time of his sudden illness he was engaged on a paper entitled, "On a Vein of Asphaltum of Hillsborough, in Albert county, Province of New Brunswick," which he has left in an unfinished state, but which is so far complete as to justify its publication in the Journal of the Academy.

VI. Bibliography.

1. *Elements of Analytical Geometry;* by Albert E. Church, A.M., Professor of Mathematics U. S. Military Academy. New York: Geo. P. Putnam, 155 Broadway, 1851, pp. 297.—Among the numerous popular fallacies is the notion that mathematics are *dry*. Any study will of course be dry when not understood. Thus, nothing is less interesting than poetry to a wholly unpoetic mind. Now, if any person finds mathematics dry, he may be sure he does not understand them. In this field, to reap where we have not sown is quite impossible. Nor can the wit of man ever lay a rail through it, to enable one, by sitting still, to go ahead.

So much apropos to a few remarks on Analytical Geometry, a branch of mathematics uniting the graces of geometry to the power and subtlety of analysis. Descartes was a truly great man. If he was too much addicted to foraging on the apples of his neighbors, his intellectual orchard bore enough of the best fruit to pay ample reprisals. The finest product of Descartes's mind was analytical geometry, which, in all its great principles, was essentially his work. Developed and perfected as it now is, the whole range of mathematics furnishes nothing more attractive or intrinsically beautiful. While elementary geometry says unimportant "things in such a solemn way" that we grow seemingly wise quite too soon, calculus treats "the ghosts of departed quantities" with a kind of transcendental sleight-of-hand, which, as Carlyle says, "grinds out the true product, under cover, without other effort on our part than steady turning of the handle." The one is too evident, the other too difficult and mysterious. Descriptive geometry also has much of beauty, but is meager in principles and tediously operose in its methods. Being so recent in its origin that Monge, the illustrious founder of the Polytechnic school, gave it shape and system, there is doubtless very much remaining to be done ere its capacities are fully developed. When it is mature, and the text-books made less clumsy, it will be the natural and fitting vestibule of analytical geometry. The clear geometrical conceptions which it would then give should precede the analysis of lines and surfaces. Without this preparation there is danger of analytical geometry degenerating into mere algebra, and thus becoming nearly barren of interest and value. No person is fit to discuss the general equation of the second degree between two variables who does not keep the geometry of the analysis clearly in mind. It is a fault of most of our analytical researches that their geometrical interpretation is too much left out of sight, so that they stand as lifeless abstractions to men whose abstracting and concreting powers fall below those of Laplace, Poisson, or Cauchy.

Analytical geometry is that branch of mathematics in which lines and surfaces are discussed by the aid of algebraic symbols. In treating plane curves two axes are assumed, and the coördinates of any point of the plane are the lines from the point to the axes, drawn parallel to the axes. The length of these coördinates for the different points of a curve are called variables, and are represented by x and y. The relation between these variables for any plane curve is expressed by an equation. In other words, the coördinates of all the points of any particular curve, as a circle, a parabola, or a cycloid, bear a constant and particular relation to each other, which relation would be a proposition in common language, but in analysis is an equation. By discussing this equation, all the properties of a particular curve may be determined in a rigorous and beautiful manner, singularly in contrast with the verboseness and indirectness of pure geometry. By using three axes and coördinates, curves of double curvature like the helix, and all geometrical surfaces like the sphere, the ellipsoid or the helicoid, can be discussed. The method is absolutely general for all lines and surfaces of a regular geometrical character, though it is not customary in elementary treatises to introduce those whose equations involve logarithms, sines, tangents, &c. The curves of conic sections,

and the surfaces generated by revolving conic sections around their axes, form the staple of these treatises. The reason of this is that any other curve or surface must give an equation above the second degree, or one containing transcendental functions, either of which makes too knotty a subject for common students, and needs the skeleton keys of calculus. Any one on comparing the facility, certainty, and conciseness of analytical geometry with the wordy, ungeneralized, and fortuitous methods of the old-fashioned conic sections, will surely bless Descartes, and pronounce this a case of stage coach versus railroad. The English have reason to know this; for their adhesion to the geometric method, under the spell of Newton's guidance, kept them long sadly in the dark, until, by a return to better reason, they were again able to read the works of their French and German neighbors.

In fine, we would say that any young man who wishes to train his logical faculties, and to acquire the most serviceable auxiliary for physical research, should venture even a little midnight oil to master analytical geometry. Elementary geometry, algebra, and plane trigonometry, somewhat thoroughly studied, will, with assiduity, resolution, and faculty, enable him to proceed without difficulty through Davies, Church, or Biot. For a beginner, the best of these will quite surely be Prof. Church's recent work. If he has not made the best English text-book on this subject, he has not done his duty. The clearness and appropriate character of his instruction to fourteen successive classes at the U. S. Military Academy, show that it was his duty to improve on his predecessors. We think he has done so to such an extent as much to facilitate the study of this subject. The reasons given in the preface justify placing the parabola before the ellipse and hyperbola, though strictly speaking it should come between. The parade of enunciation is wisely dispensed with, and timely intelligence is given that the conic sections are cut from a cone. It is a sad inversion to leave this as a parting word when we are bidding good-bye to our crooked friends. As it would be convenient to have all the principal equations and expressions of analytical geometry collected, we venture the suggestion that in a new edition, which must soon be required, such a collection be supplied. So, bidding adieu to Descartes, Biot, Davies, and Church, we retire; not, though, without expressing a hope that too-boastful America may in due time produce something above a text-book in mathematics, as well as a more numerous bevy of those who could understand it when produced. E. B. H.

2. *Maury's Wind and Current Chart.*—This large Chart, measuring 6 feet by 8 in its surface, includes a map of the Atlantic Ocean between 66° north and the equator, nearly the whole of which area is thickly dotted down with figures indicating the temperature of the ocean, and crossed by lines indicating the course of isothermal bands over its surface for the different months of the year. By using to some extent different colors for the figures and lines, the chart is relieved of complexity naturally consequent upon so many and involved markings. The author has brought out these results of his arduous labors with great beauty. The subject he has under investigation is one of the most important in the Physics of the world, and is rendered peculiarly

so by the intermingling of the Gulf Stream and Polar currents in this ocean. Navigation also, as well as science will greatly profit from these investigations, and already both departments have derived much that is new and important. Science looks forward to still more striking developments, as the subject is further studied; for Lieut. Maury, notwithstanding the number of facts already elicited, looks upon his labors as far from completed. We wish him the continued aid and encouragement of government, feeling assured that expense is gain in such investigations.

3. *Shells of New England:* a revision of the Synonymy of the Testaceous Mollusks of New England, with notes on their structure and their Geographical and Bathymetrical distribution, with figures of new species; by Wm. Stimpson. 58 pp., 8vo. With 2 plates. Boston, 1851. Phillips, Sampson & Co.—The rapid progress of Malacology within the few years past, has made numerous changes in its synonymy, changes not to be learned from any common text-book, besides showing that some supposed new species have earlier names: and the work of Mr. Stimpson will therefore be found valuable in representing the existing state of the science, especially as regards New England species. It has additional value from the notes and observations of the author on many species, his suggestions in classification, and his descriptions and figures of new species.

4. *A. P. de Candolle, sa Vie et ses Travaux;* par A. de la Rive. 312 pp., 18mo. Paris and Genève, 1851. Joël Cherbuliez.—Prof. De la Rive, the author of this Life of De Candolle, was intimately acquainted with the illustrious botanist, and entered upon his task, as he states, from his affection and respect for him. Himself a philosopher of high merit, he could well appreciate the mind and character of the philosopher whom he would commemorate. The work commences with a chapter on the earlier years of his life; and then takes up his residence from 1798 to 1808 at Paris, from 1808 to 1816 at Montpellier, and from 1816 to 1841 at Geneva. The volume closes with a catalogue of the works and memoirs of De Candolle.

5. *Iconographic Encyclopedia.* New York, 1851. R. Garrigue.—This work, which is calculated to do much for the dissemination of knowledge, speaking as it does by full illustrations as well as by description, has reached its close. It constitutes in all four thick volumes of text, in 8vo, and is accompanied with 500 4to steel plates, containing upwards of 12,000 engravings.

J. C. Trautwine, Civil Engineer: A new Method of Calculating the Cubic Contents of Excavations and Embankments, by the aid of Diagrams. 34 pp. 8vo. Philadelphia, 1851.—A work of great importance to Engineers, it giving a method of obtaining the cubic contents of excavations and embankments, by diagrams, instead of the more tedious one in use by calculation.

Army Meteorological Register from 1831 to 1842 inclusive, compiled from Observations made by the officers of the Medical department of the Army at the Military Posts of the United States. Prepared under the direction of Brevet Brig. General Thomas Lawson, Surgeon General U. S. Army. *Washington*, 1851.—As several of the various stations where the observations here published were made, are scattered over regions about which little is known in a meteorological way, this work is one of special interest.

R. G. Latham: Ethnology of the British Colonies and Dependencies. *London*, 1851.

Wm. Ferguson: Description of the Palmyra Palm of Ceylon; pamphlet, 8vo. *Colombo*, 1850.

C. T. Beke: An Enquiry into M. Antoine Abbadie's Journey to Kaffa, to discover the sources of the Nile. 56 pp. 8vo, with a map. *London*, 1850.

John Gould, F.R.S., etc: A Century of Birds from the Himalaya Mountains. 1 vol. imperial folio, containing 80 plates, with descriptive letter-press. Price £14 14*s*. *London*, 1832. "Only eight copies remain."

—— The Birds of Europe. 5 vols. imperial folio, comprising 449 plates, with descriptive letter-press, Introduction, &c. Price £76 8*s*. *London*, 1837.—The whole of the perfected copies of this work have been sold; with respect to the few that exist in an imperfect state, from the death of the original subscribers or from other causes, the author is willing to enter into arrangements with their present possessors to render them complete; or if preferred, he will give in exchange for them any of his smaller perfected publications corresponding in value.

—— A Monograph of the Ramphastidæ or Family of Toucans. 1 vol. imperial folio, containing thirty-three plates, with descriptive letter-press, &c. Price £7. *London*, 1834.—The extensive researches which have of late years been made in the great Andean Range of mountains in South America, have led to the discovery of many additional species of this group of birds, consequently a revision of the work becomes necessary; figures and descriptions of these new species will be published in the author's "Icones Avium," but will be supplied separately if required, to the subscribers to the original Monograph of the Family.

—— A Monograph of the Trogonidæ, or Family of Trogons. 1 vol. imperial folio, containing thirty-six plates with descriptive letter-press. Price £8. *London*, 1838.

—— Birds of Australia. 7 volumes, imperial folio, containing figures of 600 species, with descriptive letter-press and a large amount of introductory matter. Price £115. London, 1848.—Only 250 copies have been printed, and the drawings have been effaced from the stones.

—— A Monograph of the Odontophorinæ, or Partridges of America. 1 vol. imperial folio, containing thirty-two plates, with descriptive letter-press. Price £8 8*s*. *London*, 1850.

—— The Birds of Asia.—"The Birds of Asia" will not exceed the extent of "The Birds of Australia," and perhaps not that of "The Birds of Europe." Of this work three Parts are published, and for the present it will appear at the rate of not more than two parts a year.

—— A Monograph of the Trochilidæ or Humming-Birds.—The work will be published in Parts in imperial folio, each containing sixteen plates with descriptive letter-press, price £3 3*s*. each part, and will appear at the rate of one or not more than two parts per annum. The First Part is ready for delivery, and the second is in preparation.

—— Icones Avium, or Figures and Descriptions of new and interesting species of Birds from various parts of the World, forming a Supplement to the author's other works. The object of this work is explained in the title: it will be issued as novelties of interest occur, in imperial folio parts containing ten species, with descriptive letter-press; price £1 15*s*. each. Two parts are published.

—— A Synopsis of the Birds of Australia, in imperial 8vo parts, each containing eighteen plates, with descriptive letter-press, price £1 5*s*. Four parts published.—In this work the heads only of the various species are figured.

—— The Mammals of Australia.—The author's visit to Australia having enabled him to procure much valuable information respecting the habits and economy, and many new species, of the singular and interesting Mammalia of that country, he has determined upon publishing a work on the subject, precisely similar in execution to the "Birds," the work to be completed in ten or twelve parts, each containing fifteen plates, price £3 3*s*. Of this work two parts have been published, and have been so highly approved of, that by many they are regarded as if possible even more interesting than the "Birds." The third part is now in the press.

—— A Monograph of the Macropodidæ, or Family of Kangaroos. In three parts, each containing fifteen plates, with descriptive letter-press, price £3 3*s*. each. Two parts published.

Gustav Leonhard: Die Quarz-führenden Porphyre. 212 pp. 8vo, with 2 lithographic plates, 5 colored sections and 12 wood-cuts. *Stuttgart*, 1851. J. B. Müller. An elaborate work, full in its details.

B. Studer: Géologie de la Suisse; vol. 1, 8vo. *Berne* and *Zurich*, 1851.

Liebig and Kopp: Jahresbericht über die Fortschritte der reinen, pharmaceutischen und technischen Chemie, Physik, Mineralogie und Geologie, for 1850, 2nd part. *Giessen*, 1851.

R. T. Maitland: Fauna Belgii Septentrionalis. Pars. I, Animalia Radiata et Annulata. 1 vol. 8vo. Lugduni Batavorum, 1851. 8 *fr.*

C. D'Orbigny et A. Gente: Géologie appliquée aux arts et à l'agriculture. 1 vol. 8vo. *Paris*, 1851. 10 *fr.*

E. Blanchard: L'Organisation du Regne Animal, published in Livraisons in 4to, each containing two plates, and a leaf and a half of text. *Paris.* 6 *fr.* per livraison.

Dr. Constantin James: Guide Pratique aux Principales eaux Minérales de France de Belgique, d'Allemagne, de Suisse de Savoi et d'Italie. A large vol. 8vo. *Paris.* 7 *fr.* 50c.

L. Figuier: Exposition et Histoire des Principales découvertes Scientifiques Modernes. 2 vols. 18mo. *Paris.* 7 *fr.*

Milne Edwards: Introduction à la Zoologie générale, ou Considerations sur les tendances de la nature dans la constitutions du regne animal. 1st part, 1 vol. 18mo. *Paris*, 1851.

O. Costa: Palæontology of the Kingdom of Naples, (in Italian,) containing descriptions and figures of all the fossils found in the different formations of Italy. 1st part, 4to. *Naples*, 1850.

Dr. P. Bleeker: Observations on the fishes of the islands of Sunda and the Molluccas (in Dutch). *Batavia*, 1851.

J. B. Verany: Mollusques Mediterranéens, observés, decrits, figurés et chromolithographiés apres nature sur les modèls vivants. 1st part, Cephalopoda. 4to, with 43 plates. *Genoa*, 1851.

L. V. Svanberg: Arsberättelse om Framstegen i Kemi, for the years 1847, 1848, published under the direction of the Royal Swedish Academy.

Sak- och Namn-Register, or a General Index, to the Reports of Berzelius, from 1821 to 1847 inclusive. 312 pp. 8vo.

Kongl. Vet.-Akad. Handlingar, for the years 1847, 1848. The volume for 1848, contains Svanberg and Struve's memoir on Molybdenum, a paper by E. Fries, entitled Fungi Nalalenses, a Biography of Berzelius, a paper on the mineralogy and geology of Tunaberg, by A. Erdmann, on the embryological development of the Mollusca Acephala Lamellibranchiata, by S. Lovén, with 6 plates, besides other papers; that for 1849, among the papers, one on Swedish Homoptera, by C. H. Boheman; on Cape species of Iridæa, by J. G. Agardh.

Proc. Acad. Nat. Sci., Philadelphia, Vol. v, No. 11,—SEPT., 1851.—p. 261. A new species of Plumatella (P. diffusa); *J. Leidy.*—p. 262. The American Gordius named *G. varius*, being shown to be distinct from G. aquaticus, L.; *J. Leidy.*—p. 264. Observations on tertiary fossils of San Diego, California; *Dr. Le Conte.*—p. 265. A new Cristatella (C. magnifica); *J. Leidy.*—267. Conspectus of Crustacea of the Exploring Expedition under Capt. Wilkes, tribe Paguridea; *J. D. Dana.**—p. 272. A new American Cicada, from near Philadelphia (C. Cassinii); *J. C. Fisher.*—p. 273. Note on the new species of Cicada, and on the C. septendecim; *J. Cassin.*—OCT. —p. 275. A new Gordius (G. robustus) from the body of a Grasshopper, and a new Mermis from Brazil (M. ferruginea); *J. Leidy.*—p. 276. Note on a mammal cranium (Oreodon robustum, Leidy); *J. Leidy.*—p. 277. A new Acostæa (A. guadualana), a fresh water mollusc, order Dimyaria, from the river Guadua, New Grenada; *Mr. Lea.* —p. 278. Note on a new fossil mammal, named Arctodon; *J. Leidy.*—A new Spongilla (S. fragilis); *J. Leidy.*—p. 279. Historical sketch of Gordiaceæ; *C. Girard.*—p. 284. Corrections and additions to former papers on Helminthology, published in the Proceedings of the Academy; *J. Leidy.*—*Appendix.* Catalogue of Caprimulgidæ in the Collection of the Academy; *J. Cassin.* This number of the Proceedings contains two colored plates, pl. 7, *Galbula cyanicolis*, Cassin, pl. 8, *Bucco Ordii*, Cassin, illustrating p. 154 of the volume.

Proc. Bost. Soc. Nat. History, 1851.—p. 65. Facts on the development of Distomata; *J. Wyman.*—p. 66. Note on Holothurias of Massachusetts shore; *Mr. Stimpson.*—p. 67. A new species of Pisidium, (P. ventricosum); *Mr. Whittemore.*—p. 69. A new Holothuria (Thyonidium glabrum), from George's Bank; *Mr. Ayres.*—p. 71. Notes on the seventeen year locust; *Dr. Burnett.*—p. 73. Remarks on the Fossils of Hillsborough, New Brunswick; *Dr. C. T. Jackson.*—p. 78. Observations on vegetation in coal; *J. E. Teschemacher.*

Bulletin de la Soc. Imp. des Naturalistes de Moscou. 1849, No. 4, and 1850, Nos. 1 and 2, have been received by us.

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* See page 121, of this volume.